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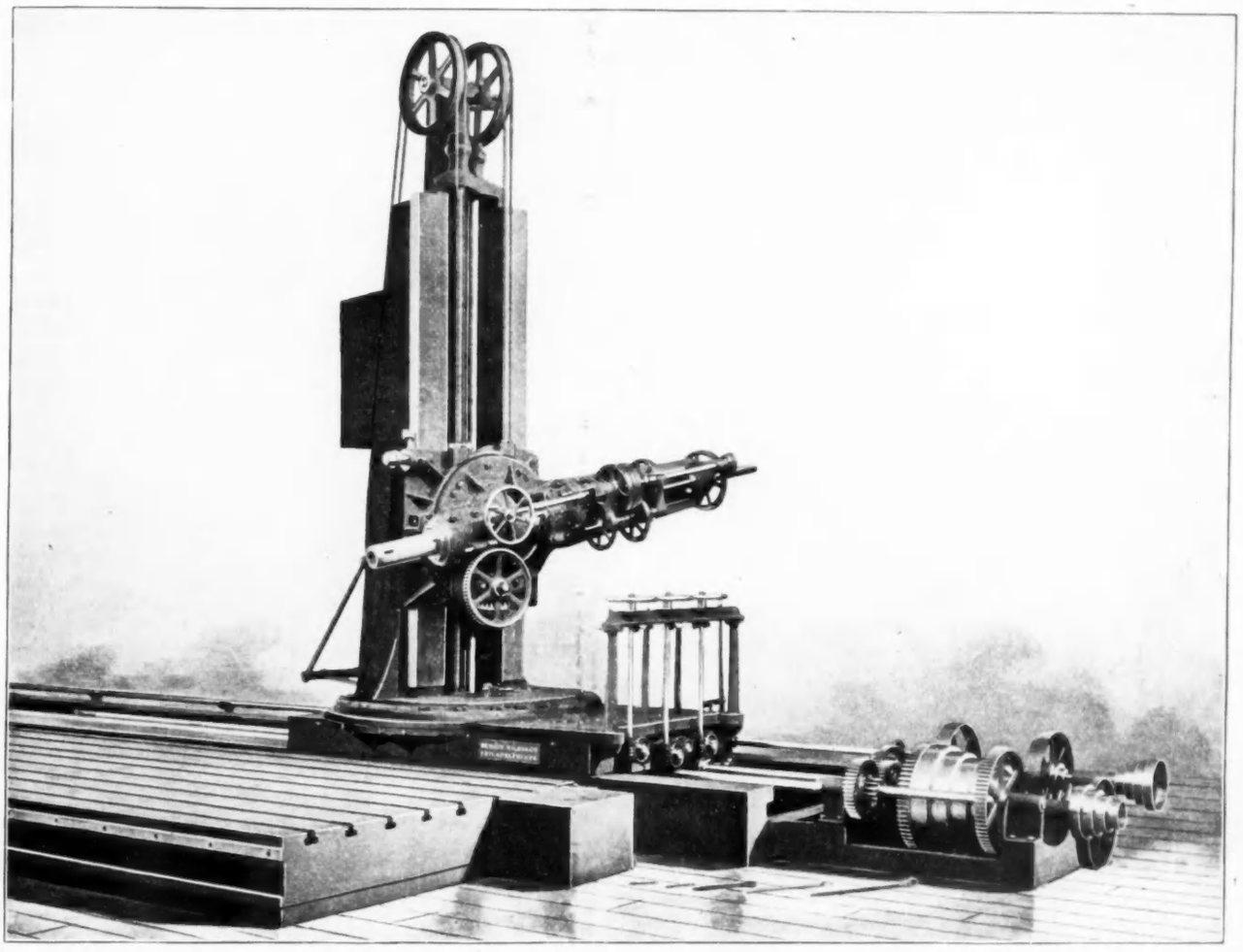
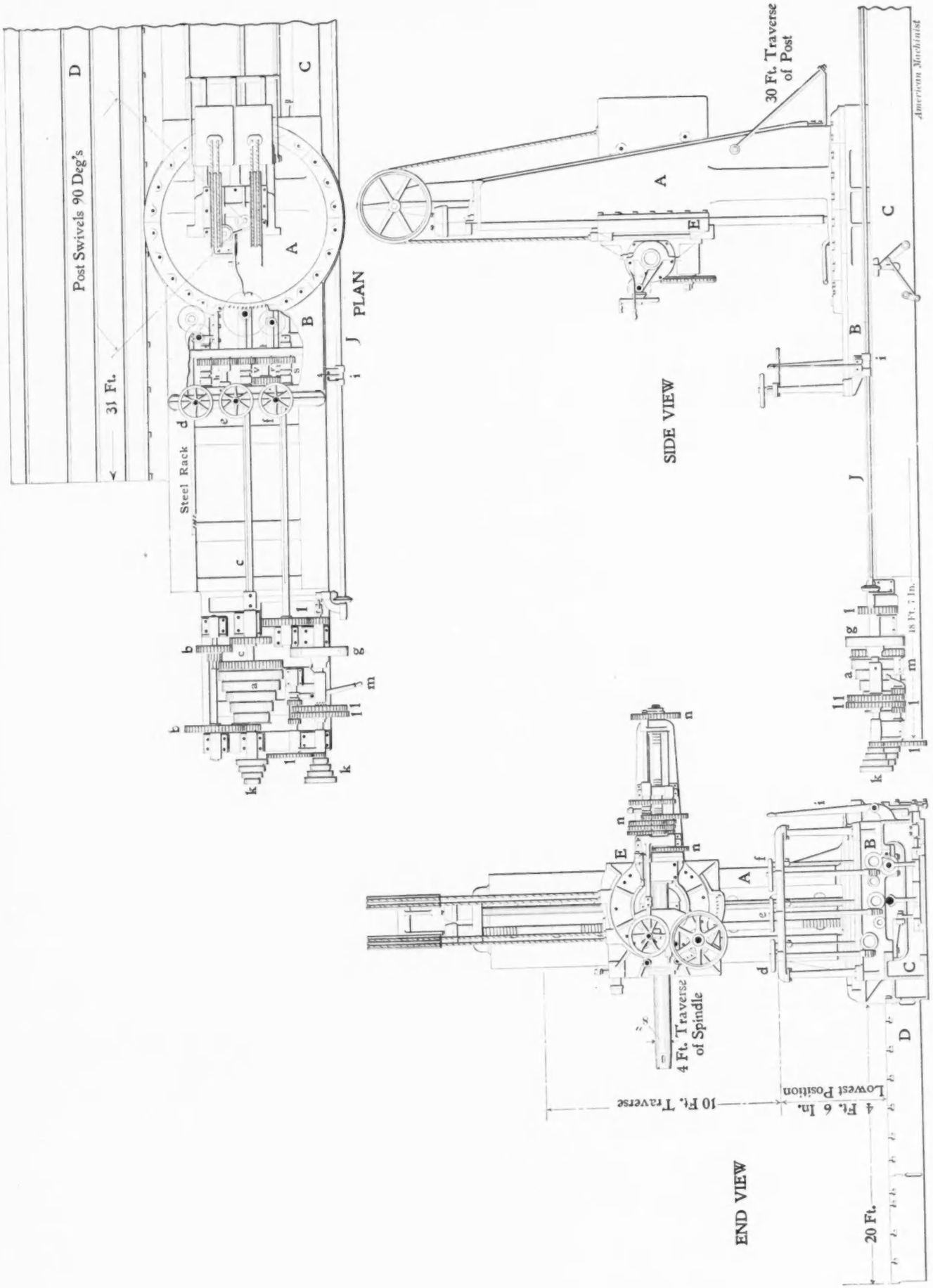
Universal Boring, Drilling and Milling Machine.

When the manufacture of armor plate was first undertaken in this country, the requirements called for machine tools of a magnitude and character which at that time had not been made in this country, and, as is well known, the armor plate mills were fitted up largely with tools of foreign make. Since that time the building of heavy machine tools has made great strides here, and it is safe to say that not many more such tools will be imported. As an illustration of the progress in this line of work, we present a photographic view as well as plan and elevations of a superb piece of heavy tool construction which has recently been supplied by Bement, Miles & Co. to the Bethlehem Iron Company.

This machine consists of a heavy column *A*, with a circular base, upon which it swivels by hand and power, resting upon a carriage *B*, which traverses 30 feet by hand and power, upon a bed *C*. At one side of the bed is a work table *D*, 20 feet wide by 31 feet long. Upon the face of the column a counterweighted saddle *E* traverses vertically 10 feet, by hand or power, carrying a steel spindle 8 inches in diameter, with 4 feet traverse by hand, or by variable feed motion. The traverse of the column upon the bed, of the saddle upon the column, and the swiveling of the column horizontally upon its axis, are all arranged so as to be operated either rapidly by quick traverse gear, or slowly for feeding in any direction, and for fine adjustments by hand. The spindle can also swivel upon the saddle in a vertical plane. This combination makes the machine truly universal in every sense. The bed can be shortened or lengthened for more or less traverse horizontally, the column can be shortened or lengthened for more or less traverse vertically, the motions of the spindle can be increased or diminished, as required, and the dimensions of the work table can be adapted to suit the work.



UNIVERSAL BORING, DRILLING AND MILLING MACHINE.



UNIVERSAL BORING, DRILLING AND MILLING MACHINE.

The functions of the machine are effected as follows:

The cone *a*, of 5 steps, is arranged with two changes of back gear *b b*, giving 15 speeds, or, if required, 30 speeds by double shift on the countershaft. The cone and back gearing are arranged similarly to those of a lathe spindle, which is represented by the driving shaft *c*. Their function is to revolve the spindle.

The arrangements for controlling the traversing and feeding motions of the machine are shown upon the plan view. The clutch *h* engages the horizontal traverse gearing, and the hand wheel *d* gives the fine adjustment by hand horizontally. The clutch *v* engages the vertical traverse, for which the hand wheel *e* gives the hand adjustment. The clutch *s* engages the swivel motion of the column, for which the hand wheel *f* gives the hand adjustment. The clutch *r*, seen below *s*, reverses any or all of these motions.

The pulley *g* gives the power for actuating the traverse motions of the machine. They are controlled by the vertical hand lever *i*, seen at the right hand side in end view. This lever, traversing with the carriage, operates the rock shaft *j*, which runs the whole length of the machine. In one direction, the hand lever *i* applies the quick traverse motion to any of the traverses which are engaged; in the other direction, it applies the slow feeding motion for milling.

The milling feeds are actuated by cones *k k* and gearing *l l l*, a change in the gearing being effected by the horizontal hand lever *m*, seen on plan.

The feed motions for drilling and boring are actuated by the gearing seen in the end view at *n n n*. The swiveling of the spindle in the vertical plane is arranged in this machine for hand motion only, as a power traverse would be of very little use.

The operator, standing upon the platform of the carriage, can control and manipulate all the operations of the machine, except the speeds given by the cones and gearing.

The purposes to which this machine is to be applied are chiefly the machining of the edges of armor plate and the cutting of port holes in ships' turrets. For this work the three functions of drilling, boring and milling are all required, and the machine has a complete complement of speeds and feeds suitable to all of these operations. The shapes of ships' armor are so diverse as to require the universal adjustments, although these have largely increased the complexity of the driving gearing, of which the plan and elevations give no adequate conception, as the gears involved in the performance of these functions are partly out of sight, being indicated only by pitch circles. The machine is universal in an additional sense over that suggested by the fact that the spindle is adjustable in inclination in both the horizontal and vertical planes. This feature is only indicated in the drawings, as certain fixtures have to be applied for this purpose which differ with the different jobs, and are consequently to be fitted to the machine by its owners. This feature is indicated by the short stud seen projecting from the upper left-hand corner of the post saddle in the end elevation. The purpose of this pin is for connection to a radius link, which is to be swiveled from a corresponding pin attached to a stationary support, at a point depending upon the work to be done. The vertical feed motion of the post saddle may be disengaged, and when so disengaged—the saddle being hung from such a radius link—it is obvious that when the post is fed horizontally upon the bed, the spindle will traverse the arc of a circle, whose center is the stationary pin of the radius link. The purpose of this provision is to enable the machine to mill a rabbeted joint upon the circular bottom of ships' turrets.

The magnitude of the machine will be understood from the dimensions already given, to which may be added the fact that the center of the balance sheaves on the top of the columns are 20 feet above the surface of the floor plate. The entire length of the machine over all is 51½ feet and the gross weight is 240,000 pounds. An additional means of estimating the size of the machine lies in the fact that the hand wheels upon the operating platform are about waist high for convenient manipulation. The workmanship is of the well known high character characteristic of its builders, and the machine is in every way a notable piece of work.

Machine Grinding—I.

BY C. H. NORTON.

In dealing with this subject the writer realizes that there is so much yet to learn that what appears like truth to-day may prove to be error to-morrow, and that, consequently, there may be errors in this article. But one of the world's greatest thinkers has said that "Men are educated and the State uplifted by allowing all—everyone—to broach all their mistakes and advocate all their errors." While there are so many open questions, yet there are very many settled facts in regard to machine grinding that seem to be little understood even by those who have used the grinding machine for years. It is to help clear away misunderstandings, and, if possible, open the way to the more profitable use of grinding, that the writer has prepared this article.

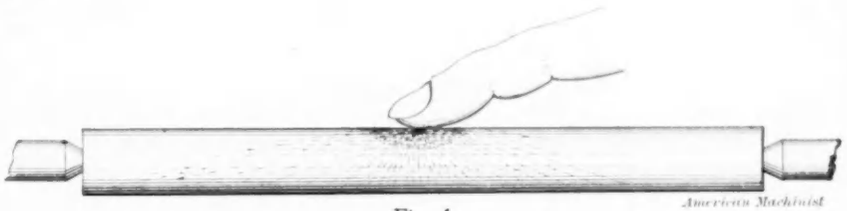


Fig. 1

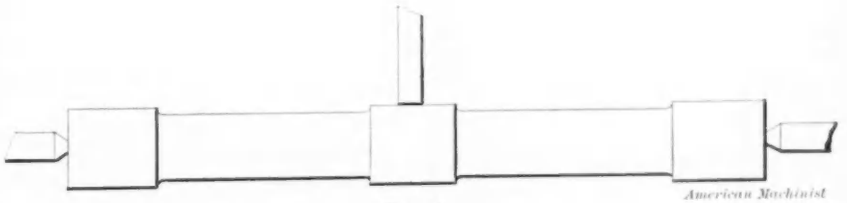


Fig. 2

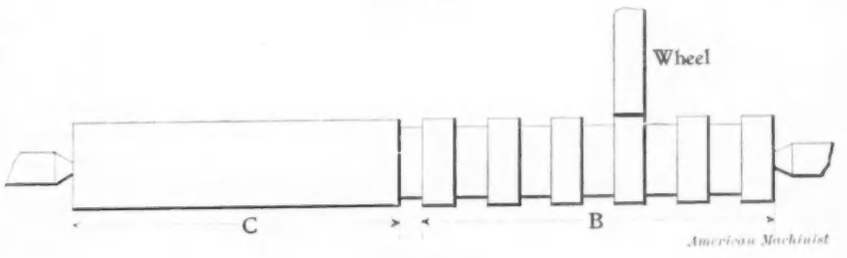


Fig. 3

THE EFFECT OF HEAT IN GRINDING.

It is probably true that very few mechanics appreciate the possibilities of the grinding machine, and that the largest users of it have as yet but partially understood its value. The grinding machine has been in use many years, but the greatest strides in the knowledge of its use have come in the last few years, and at present much is being learned that places it in the front rank of labor-saving machines. A recent writer in these columns has attempted to explain why a grinding machine is not a lathe, and a lathe not a grinding machine; also why we grind at all. The grinding machine needs no apology for being with us. It is an established fact. One need only to make an

intelligent use of grinding to understand, first, why we grind at all, and then why with a machine constructed for that purpose rather than with one constructed for an entirely different purpose. At the present time the first reason for grinding is economy of time; the next is accuracy. If the grinding machine can but have the same helps as those given to other machine tools, it will show economy that few realize. It has already proven its ability to grind unhardened steel, removing from five to ten thousandths (giving accuracy possible with no other process) in less time than a cut can be run over the same piece in the lathe; thus saving the sizing cut that would be necessary if the piece were to be filed to size; the refinement in this case costing nothing. With hardened work, grinding is the only means we have of working it, so that no comparison with the lathe is possible.

It seems strange, after the care the makers of grinding machines have taken to make known the facts, that the great majority of mechanics should to-day look upon it as a machine for hardened work principally, and when occasional exceptions are made, that they should find the grinding an additional expense; but such is the case with many. The writer has met but few grinding machine operators, failing to get the best results, that did not know that their conclusions about the machine, the work and wheel were just right; while, on the other hand, those who were getting the best results were always open to suggestions.

A grinding machine will size and perfect cylindrical or conical work of steel, hard or soft iron, cast iron, chilled iron, brass, copper or rubber. A first-class machine will size all of these substances with accuracy, and with a saving over ordinary methods. A universal machine will, in addition to this, grind the sides of saws and cutters of various forms, as well as holes, both straight and taper. It can also be used to back off cutters and reamers, and with special attachments many other things can be done in the way of tool work and manufacturing.

To use the grinding machine successfully, one must understand that not only the machine, but the wheel and the work itself have each their own part to play, and any failure of the wheel or work to perform their parts accurately will cause errors for which the machine is in no way responsible.

Any change of axis of the work will cause error. It is changed by wear of poor centers, by carelessness in cleaning centers, and by changes of temperature caused by the wheel. First of all, care should be taken to have all centers large enough and of standard 60-degree angle, and the centers of lathes and grinding machines should really fit these centers. Then both the lathe man and the grinder should see that these centers are clean and oiled. Next, sufficient water should be used to prevent the temperature from changing sufficiently to change the axis or outline of the work. This can be prevented if the wheel is suitable for the work being done; if not, no amount of water will cause it to produce good work. The changing of outline or axis is, perhaps, one of the most common difficulties met with, and, strange as it may seem, very few mechanics having grinding machines can be made to believe that their trouble of this kind is from this cause, but, with few exceptions, they look for a remedy in the machine itself. This feature calls for careful consideration, and the writer will give such instances as he has met with in his experience, and such explanation for them as his experience suggests.

Change of axis causes the wheel to cut upon one side more than the other, after cutting uniformly around the entire circumference. This is something beyond the control of the machine. If this cut on one side should be uniform from end to end, and the same at each end, then it would be caused by wear to one side in both centers, and that the same side, or by a foreign substance in each center, on the same side. This would seldom if ever happen; the writer never saw such a case, viz., a uniform cut from end to end on one side. If the cutting on one side should occur at one extreme end, and cut concentrically at the other end, it would be caused by either a wear of one center or the introduction of a foreign substance in that center. Work can have such poor fitting centers that the axis will constantly change and the work never come round. It costs just as much to produce poor centers as good ones, so there need be no difficulty in this direction. When this change of cut is caused by a change of temperature, the cut is always deepest at a point usually about midway between the centers. There is never any trouble from this cause until the turning marks are all ground out and the wheel has cut entirely around the piece.

When we speak of change of temperature, we do not mean that the change is necessarily sufficient to be detected by the hand. It is probable that few pieces of steel are so uniform in texture that they will not change their outline with a very slight change of temperature, even though the temperature be uniform over the entire bar. This alone would bend most pieces more or less, causing a cut of the wheel upon one side more than the other. It is also well known that in steel the slightest increase in temperature of one part more than another will cause a change in outline. If we place a finger upon one side of a bar, it will cause an elongation of the metal immediately under it. I think it is clear that the surface will be warmest, and that it will remain warmest at this spot so long as the finger which is the source of heat remains. The heat from the finger will be absorbed by the bar as in Fig. 1, leaving the warmest point where the heat enters. The bar will remain curved until the finger is removed, when it will straighten immediately. We understand that the amount of expansion and of curvature would be very small; but when we consider that a clean-cutting wheel in many cases will show sparks with a cut less than one hundredth part of one thousandth of an inch deep, it is easy to understand how a very small change of outline will be detected by the grinding machine.

Now let us apply the wheel to the bar, and when we see the red-hot sparks of steel pouring from the bar, we can understand that there must be considerable heat at the point of contact. From what I have said, we can see that this heat must always be greater at that point than elsewhere, and that the bar must constantly bend toward the wheel, as a shaft would revolve if its hangers were too far apart. It is from this cause that, in many cases, the workman speaks of the wheel as "drawing in," when it is the work that approaches the wheel, by revolving with a greater expansion under the wheel than elsewhere. As with the shaft when its hangers are too far apart, this bar will not, as a rule, bend with perfect uniformity, owing to unequal tension within itself. A given amount of heat being more effective on one side than the other, the wheel grinds deeper on one side than the other, and the instant this occurs, the deeper cut will develop more heat than the other, until it is sufficient for a portion to remain until it revolves to the wheel again and is added to the heat of the next revolution, thus expanding more until the bar is bent enough to revolve without touching the whole circumference, when, the heat being entirely on one side, the bending increases.

I speak of the heat remaining until it revolves to the wheel again, by which I mean that it is not absorbed by the mass fast enough to equalize, but is still greatest on that side. This unequal bending and consequent unequal grinding of the two sides cause the wheel to cut on the opposite side on its return cut, for the reason that when the heat is equalized in the bar, as it will be almost instantly with the removal of the wheel, the bar returns to its original position, leaving the other side of greater radius. Now, the wheel cutting on this side alone, causes the bar to bend this side toward it, leaving the bar elliptical in form, and if, as sometimes happens, these two bends have been exactly opposite, the next time over, the wheel will cut on two points, and if the bar is of perfectly equal tension on these two sides, the wheel will continue to cut both sides; but it is usually the case that it will not, and that the bar will not bend exactly opposite at first, so that the cycle will, as a rule, continue first all around, then on one side, then the opposite, then at right angles, then opposite again, and so on.

When tubing is ground, this change, due to expansion, is more aggravated because, being hollow, the heat is not conducted to the opposite side of the axis so rapidly.

This grinding on one side and then on the other will never occur with a suitable wheel and plenty of water running directly upon the work at the grinding point. When a bar has once been round, and for any reason is grinding on one side, the remedy is to run it very slow and take very light cuts with a liberal supply of water, and, if the wheel is hard, narrow its face. When grinding round again, increase the speed of work, allowing the wheel to wear to the full face, and, with plenty of water, proceed. If the trouble returns, you have either too little water, too hard a wheel, or too great a speed of wheel, or you should clean the wheel. Ordinarily, however, the wheel should be self-cleaning.

It is easy to be deceived as to the amount of error in roundness, when judging by the sparks from the wheel. A piece 36 inches long and 3½ inches diameter, was grinding, with sparks showing from one side only. Without correcting the error, the piece was measured with the micrometer, and its error was so slight that it could not be detected. An indicator held against it while revolving, did not show motion. A hardened plug, 1 inch diameter, was ground round and straight, and measured, then placed again in the machine, and the wheel advanced until sparks were just visible; then, when ground this amount, it was again measured, and found to be about one one-hundredth part of one thousandth smaller. When we know that, with water, the right wheel will grind long work that will show sparks entirely around, with a cut so light that the sparks are just barely visible, we can feel sure that the perfection of the work is very great. This result is obtained without difficulty.

I have stated that a bar was not affected by change of temperature until the turning marks were all ground out. There are reasons for this. One is that these ridges act to file the surface of the wheel, causing it to cut more freely. Another is that, there being less work done when cutting the ridges, there is less heat generated; also, the fact that the surface is not continuous prevents expansion endways of the warm side of the bar.

To illustrate: A test bar was made like Fig. 2. It was found that dry grinding would cause this bar to grind first on one side, and then on the other, as before described. A bar was then made like Fig. 3. Grinding dry on this showed that, when grinding along over *B*, no change of outline occurred, although the heat was sufficient to turn the surface blue. The instant the wheel cut upon the portion *C*, the piece changed its axis and ground upon one side only; cutting upon the opposite side on the return cut, and grinding all around when on the portion *B* again. The reason for this is that while the surface of each of the rings expanded parallel with the axis, yet the bar was not bent because they expanded into the space, and the heat became so distributed before reaching the bottom of the grooves that no change of axis occurred; also, there was less work done over *B*. This bar was ground until these rings were entirely ground off, and no change in results was noticed until these rings were less than one hundredth of an inch high, when the piece began to bend to one side and then the other, increasing in amount as the traces of rings disappeared, until the change from one side to the other of the axis became so great that it was necessary to stop the machine to prevent the bar being torn from the centers and the threatened destruction of the face of wheel. The same cut was taken on this bar with a liberal supply of water, and it ground round and smooth, with no show of change. Work that will grind smooth with water will many times develop minute vibrations when grinding dry; there seems to be a rapid fluctuation of temperature, causing the work to approach and recede from wheel very rapidly, leaving a mottled or rough surface.

A fluctuating supply of water will sometimes cause a fluctuation of the cut sufficient to mar the work, and nearly always enough to show a change of sparks. The water should run upon the work smoothly if nice work is required. A certain machine would not grind evenly; the position of the water-pipe was changed and the flow increased, so that the supply was constant at the point of cut, and the trouble disappeared. Until then it was supposed that the wheel was changing position.

There are times when water would be unnecessary, and, in fact, a disadvantage, but this is almost wholly with tool work, and in cases where a very narrow-edge wheel, to cut in narrow corners, is used under conditions where the cut is so light that it can have no influence upon the outline of the work; also with face plate or chuck work, and where one wishes to see clearly the edge of the wheel to touch some particular spot. But when real work is to be done, the cut must be such that the work will be affected unless water is used liberally. While most tool makers do all of their work dry, they do so at great expense of time.

Just enough soda should be used in the water to show on the finished work and machine when dry. There is then no danger whatever to the machine if it be wet all over, and the work will need no care to keep it from rusting. Many fear to wet their machines, but this fear seems to the writer to be unwarranted. As an extra precaution, the machine can be painted with cosmoline or thick oil. The writer thinks, however, that soda water is sufficient.

Some Questions.

As a sample of the questions which we have the privilege of replying to, and generally of answering when we are able to, we have just now three or four that have come in very close together, and which may be regarded as typical questions, each embodying some characteristic of frequent occurrence.

M. S. T. asks for "a rule or formula to find the length of one side of an inscribed equilateral triangle, the diameter of the circle being given, also for a pentagon, hexagon, heptagon, octagon, etc. I often have jobs where the diameter is given and must be cut 3, 4, 5, 6, etc. sides, just as large as the diameter will allow, and sometimes I have the length of the side given and must find the diameter to turn a piece that will cut the right size."

Reading the above question convinces us that the writer has in himself or at his hand the means of completely answering all the above, and of answering it in a way vastly more helpful to him than any answer that we could give. He should study elementary geometry, which would not only give him all the information here asked for, but vastly more in the same line, which would be of constant use to him and make him of much more value to himself and to his special line of business.

It is strange and unaccountable that those engaged in mechanical occupations do not more generally see the absolute necessity of studying geometry. It is at once the most valuable of all studies for the mechanic and the one most easily followed without a teacher. In fact, in learning the principles of geometry, it is almost impossible for an instructor to be of any assistance except in the way of a stimulant.

It is probable that our inquiring friend has an Engineer's Pocket Book, or he should be able to borrow one, or some book of common tables, in which also he would be able to find the information asked for above.

If he could manage to get the use of a flat surface anywhere, say a yard square or less, a pair of compasses and a straight edge, he could lay out a diagram that would be of permanent use to him and settle the matter for him for all time. If we were in his position we would probably do this thing, saving our postage and our independence and adding to our facilities for doing our work all at once. If a circle, say two feet in diameter, is drawn, it is a simple matter to divide it into the required number of parts and draw the lines for the different polygons, and the length of them can then be taken and recorded. If the lengths are required for any other diameter of circumscribing circle, they may of course be found from these by simple proportion. The diagram which we give herewith is a convenient way of arranging this information. It is of course not engraved to scale, but will show how it may

be made. The right hand vertical line shows the relative length of side for a radius of 12 inches. For other radii the lengths may be taken from the other vertical lines. If the diagram is drawn upon section lined paper, the lengths may be read off without measuring.

W. F. H. asks: What is the number of threads to the inch in the Whitworth or English gas pipe threads? This is a question in every way right to address to us. The information sought is needed by many who have to do with English pipe fittings, and it cannot be evolved from any internal consciousness, and is not generally accessible in this country. We find it in Molesworth as follows:

Dia. of pipe.....	⅛	¼	⅜	½	¾	1	1¼	1½	1¾	2
Threads per in..	27	19	19	14	14	11	11	11	11	11

The list includes, it will be noted, 1¾ inch diameter, which we do not use. For sizes above 2 inches 11 threads are used, instead of 8, as with us.

J. A. T. sends us a sketch of a "ground" wheel made of two boiler heads ¼ inch thick and 60 inches in diameter, mounted upon an axle, the edges flanged inward and a shell of tin riveted on. We do not know how far the heads are apart, or how big the axle is, or what the wheel is used for; but we are asked to find the strength of it. We very regretfully are compelled to give it up.

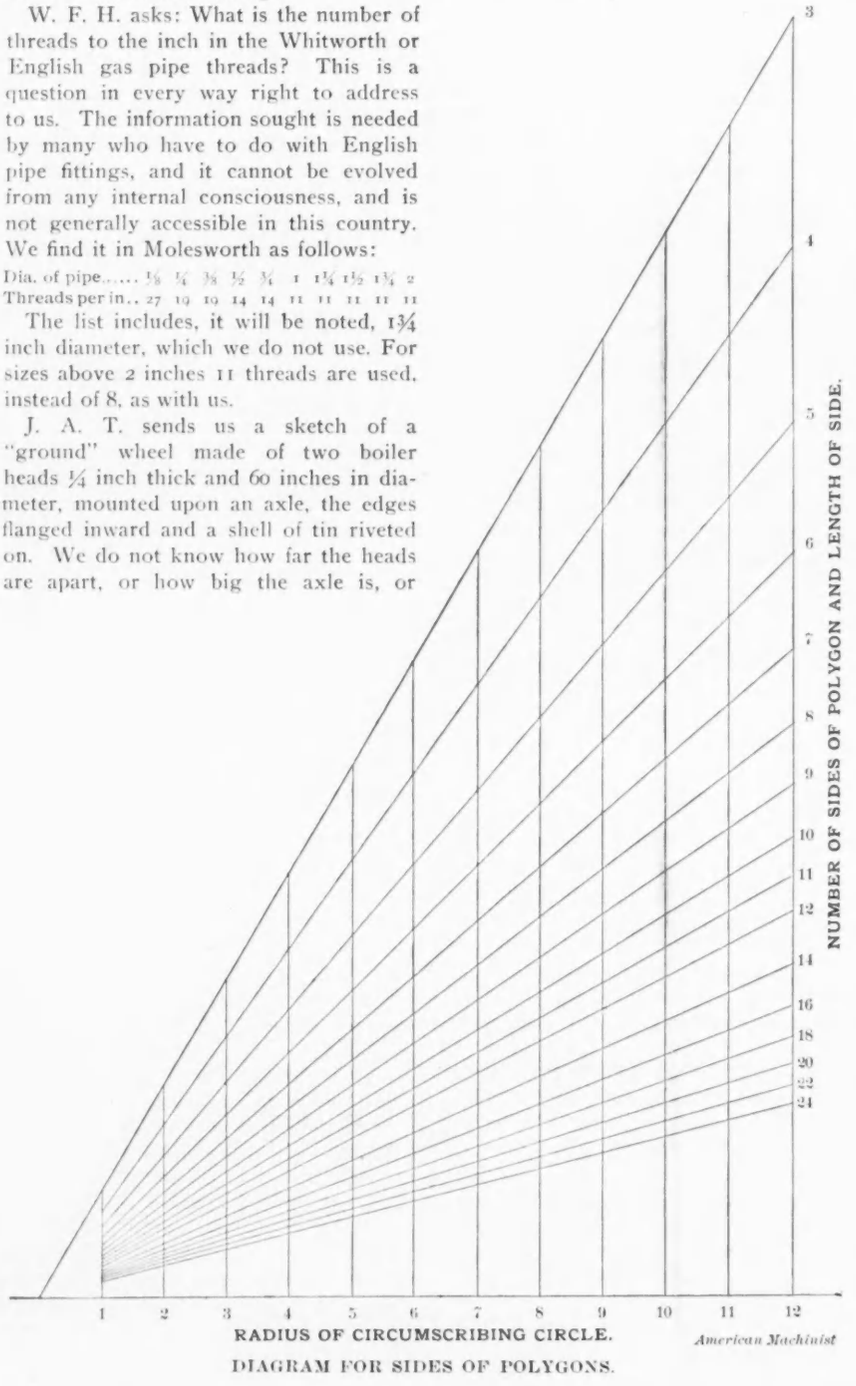


DIAGRAM FOR SIDES OF POLYGONS.

C. S. writes: "I would like to get some idea about planing a large angle plate, 14 x 14 x 24 inches, the only other plate in the shop being about 12 inches each way. I planed the long part first, but that being done, I thought the short side should have been planed first." There was probably no mistake made in planing the long side first. We would probably have done it in that way. No sketch is given of the angle plate, so that we do not know what chances there were for blocking or for bolting it. A separate article on this subject would be the way to dispose of it, and such an article may come along one of these days.

G. H. wants to know the proper thickness for the shell of a cannon "with a ⅝-inch hole at the mouth," or the dimensions of a cannon 12 inches long, to be made of brass; wants it for the Fourth of July. This is a matter of taste or daring, and we can take no responsibility in the matter except to advise the making of it as strong as possible.

A. K. asks: Will you kindly explain the mode of lining an engine, and also how to find if a connecting-rod is properly hung? Probably it would generally be considered a rather large question if someone were to ask how to play a violin or how to run a locomotive. The above question is really one of somewhat similar dimensions. The lining up of an engine, or rather the setting of it in correct working condition is an operation including many details and requiring a variety of knowledge which comes only with experience and which cannot be successfully formulated. We might say that the central line of the engine should first be determined, or a provisional central line should be assumed; and the several parts of the engine then be so adjusted as to be in symmetrical relation to this central line, but this would probably convey no information to anyone. The operation of "lining up" is one of minute detail, any item of which might be expatiated upon at unlimited length, but all of which could not be included in any verbal description. Little by little the art may be acquired by observation, thought and practice. Many engines of modern construction do not permit of lining up, according to the old-fashioned use of the term, and each style of engine differs from the others in this respect, so that if any description of the operation of lining up could be attempted, a full description of the individual engine and its connections should first be given.

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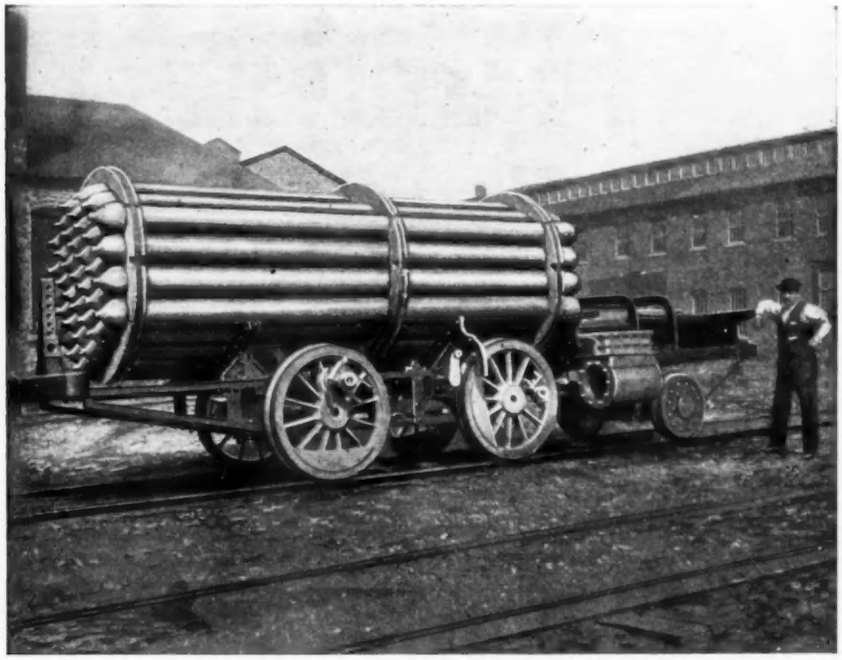
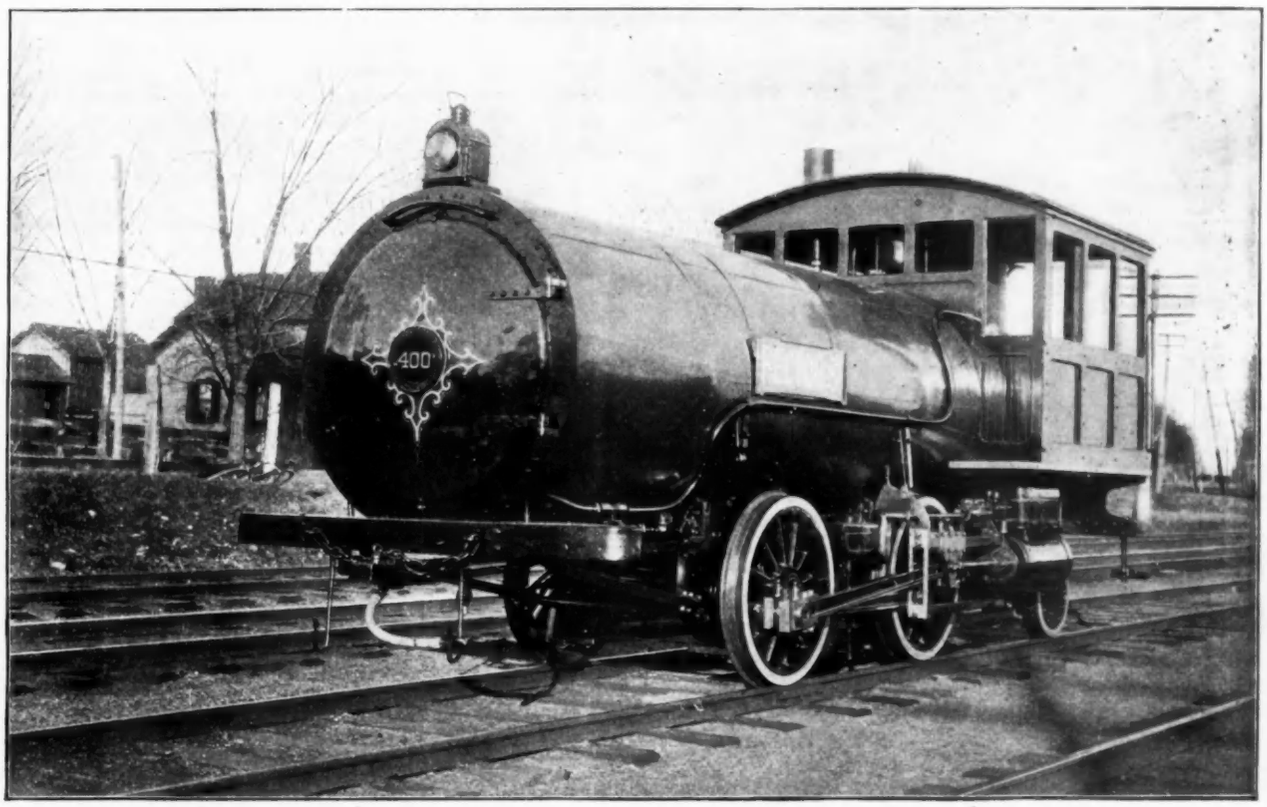
Compressed-Air Locomotive for the Manhattan Elevated Railroad.

The half-tones give a good idea of the general design and appearance of the compressed-air locomotive now about commencing its trips upon the Manhattan Elevated Railroad of this city. The first view shows the frame of the machine and the arrangement of the compressed-air reservoir, and the second shows the complete machine. The air, at a pressure of 2,000 pounds to the square inch, is carried in thirty-six Mannesmann tubes, each 9 inches diameter and 15 feet 6 inches long, the total cubical capacity being 246 cubic feet, which, at the above pressure, equals 33,702 cubic feet of free air. The weight of the full charge of dry air, by the way, will be over 2,500 pounds.

The tubes are all so connected, the connections being all in the forward end and easily accessible, as to form one continuous reservoir. The air from the reservoir passes first to a pressure reducer which maintains a constant working pressure of about 150 pounds, which pressure, within certain limits, may be varied under the control of the engineer. The air, after its re-expansion to this working pressure, passes through a vertical tank of hot water in the cab. This water is heated by steam, at each recharging of the air reservoirs, to about 350 degrees Fahr. The air passes

actually through the hot water, and is thereby not only heated and expanded, but takes up a volume of steam about equal to one-half its own volume, the actual practical result of the expansion of the stroke, being placed, as will be noticed, under the cab instead of in the usual place forward. This arrangement is adopted principally to secure as short a run as possible from the heater to the cylinders.





COMPRESSED AIR LOCOMOTIVE FOR NEW YORK ELEVATED RAILROAD.

air and the mixture of the steam with it being to double the work done by the air.

From the heater the air goes as directly as possible to the engine cylinders. These are 13½ inches diameter and 20 inches

As the cylinders on the steam locomotives of this line are only 12 inches diameter, the air locomotive will have more power, will start the trains quicker from the stations, and will be able to make better time, although with the other trains in the way there may be little chance to show this. The unique record of the Hardie compressed-air cars upon the One Hundred and Twenty-fifth street line, in this city, warrants us in anticipating excellent results from this locomotive.

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An Example of Modern Press Work.

We present herewith some illustrations of a power press fitted with a special feed and dies—the latter with the work produced by them being shown separately. Regarding the press itself, not much is to be said except that it is a late design, and representative of modern practice.

Fitted to the press is an automatic feed, by which a strip of spring steel is fed into the machine, and the dies then cut it into suitable lengths and form it into springs, one of which is shown at Fig. 3. The dies *F* are shown looking at them from the rear in Fig. 2. These are, of course, behind the feed rods shown in Fig. 1 and, as the strip passes through to the dies, a suitable length is first cut off and then, when the slide rises, this piece descends by gravity down the inclined surface of the die, and is stopped by gage pieces shown attached to the forming die in Fig. 2. The next descent of the slide forms this piece and also cuts off another one ready to slide into place at the next upward movement; each stroke of the machine completing a spring automatically.

The press can be very rapid in action,

running at the rate of 150 to 200 strokes per minute. Some difficulty was experienced at the first in getting the pieces to slide properly, which, however, was overcome by the use of kerosene for lubricating the under part of the steel and a heavy black oil which would prevent the punch

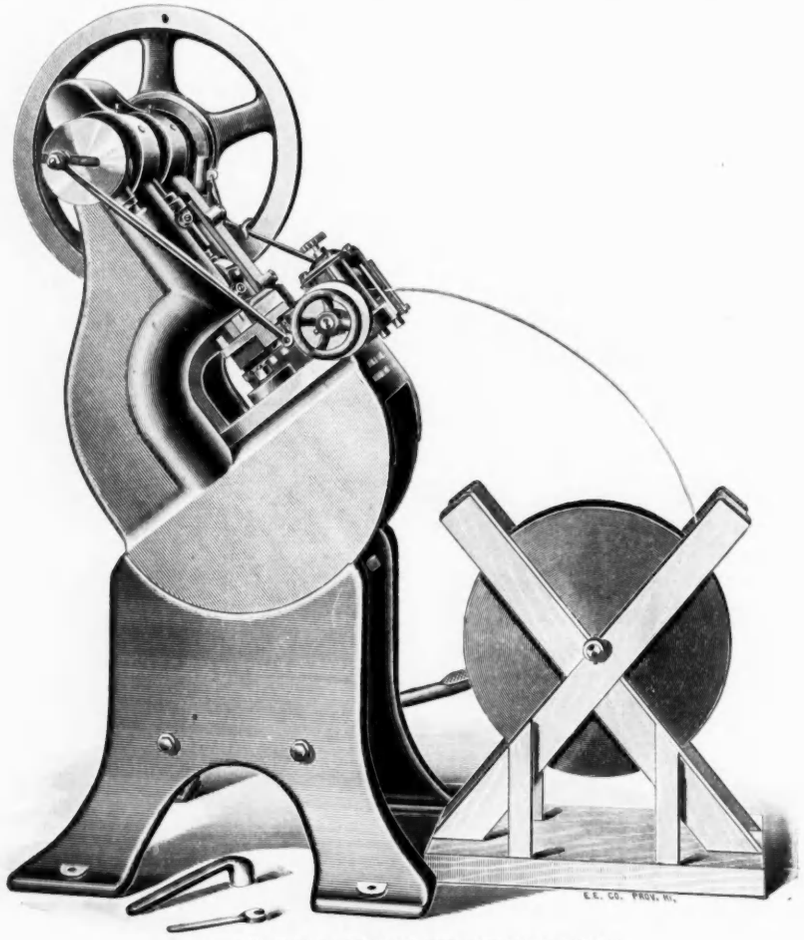

Fig. 1. POWER PRESS WITH SPECIAL FEED.

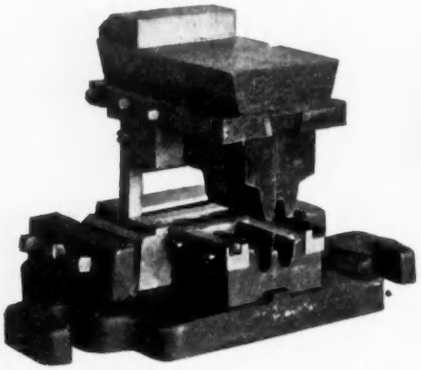

Fig. 2. REAR VIEW OF DIES USED.

from cutting or "roughing up," on the upper side of the stock.

The press is inclined to an angle of 40 degrees, which is found to give the best results in feeding. No stock whatever is wasted in the production of the spring, the strip being of just the proper width to make the required length of spring, and by changing the amount of feed, any width of spring can be produced with the same dies. This method of work can be followed in many dies, especially in making springs which are now usually produced by a separate operation of punching and then bending, and besides a saving of money, would also save many jammed

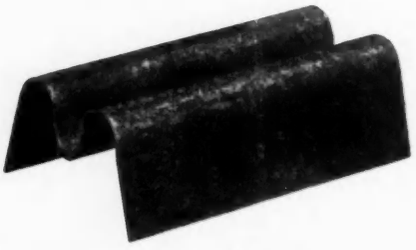

Fig. 3. THE SPRING MADE.

fingers, for we know of no operation in press work which is more productive of the latter result than spring bending. The press and tools were built by the Mossberg & Granville Manufacturing Company, of Providence, R. I.

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The breaking strain of a strip of leather belting, 1 inch wide by 3-16 inch thick, averages 530 pounds. The breaking strain of rubber belting, three ply, the strip being 1 inch wide, averages 600 pounds. The factor of safety is: for leather, 16; for rubber, 8.

Cutting Semi-Cylindrical Concavities.

Not Often Required—Common Tools Inadequate—Grubbing Resorted to—Form of Cutter—Mode of Motion—Making Joint for Vise Hinge.

BY B. F. SPALDING.

If we take the cylinder of a pistol and saw it through the center-pin hole into halves, each half will be flat on each end and on the sawed side, while the other surface will be half round. Suppose it was sawed before the holes were drilled, and one of the half cylinders was laid, round side down, upon a block of red-hot steel, as shown in Fig. 1, and in this position put under a drop and the hammer allowed to strike it and drive it into the steel, thus sinking a die the same as it has been common practice to sink dies since prehistoric ages, the impression which would be made would be half round.

How could such an impression be cut out instead of stamped in? How can a recess of this form be shaped with any of the ordinary tools of the machinist? It is not ordinarily a matter of much importance how this thing can be done, but the importance of anything is conditioned upon circumstances, and the condition of circumstances in which an armory found itself once upon a time made the question important to its managers, for they had this kind of an impression to make on the frame of a revolver they had contracted to manufacture. In the case instanced, of cutting such an impression in a die, the recess could not be made on a planer, shaper, lathe, drill press, or milling machine, but some of the stock could be removed with either of the three last named tools, and the impression finished by hand. This would be practicable in die-sinking, where only one or two impressions were to be made, but it would not be so when thousands of such impressions were to be made with uniformity, as was the case when each pistol had to have such a cut. The cut, to be sure, was small, but not on that account less difficult to make. Probably in all practice the rule holds good, that high values are in small packages. Lawyers say there is often more law in a five-dollar case than in a million-dollar railroad suit; so there may be more of the art of mechanics in grubbing out a three-eighths of an inch half-round recess than in planing off a big planer platen.

The parts of this pistol were to be interchangeable, like Colts, which had been made so ever since the establishment of the works in Hartford, in 1848, after the previous experience at Patterson and Whitneysville. The center pin was part of the frame, forged solid with the breech. The barrel screwed into a sleeve which passed over the top of the cylinder and hinged to the top front end of the frame, as shown in Figs. 2 and 3. This job of making the semi-cylindrical indentation was in making the hinge seat at the front

end of the frame. The circle of the hinge was, for the smallest frames, perhaps 5-16 inch in diameter, and the hinge pin might have been 1/8 inch in diameter. The problem was, how to cut out the stock between the two side ears to the full depth and to the right circle. The hole through the

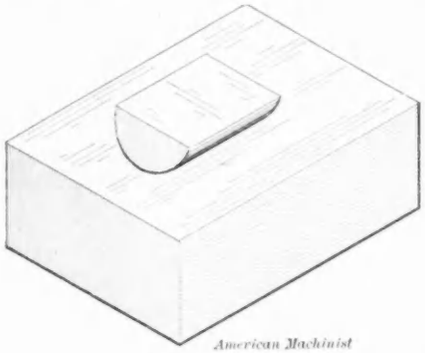

Fig. 1

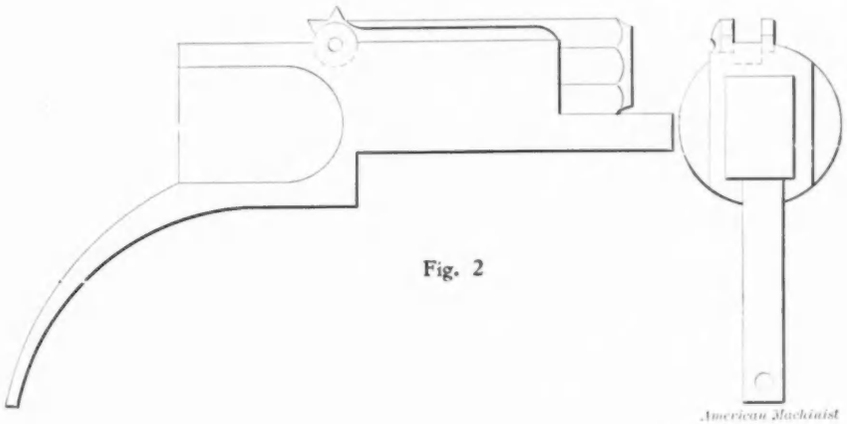

Fig. 2

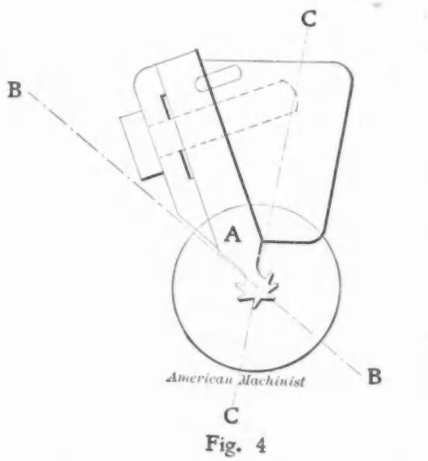

Fig. 4

center gave no relief in this case, because it was too small to be useful.

It was decided to mill through, with a cutter of the right width, between the ears after the center hole was drilled, and then to take out the balance of the stock by a grubbing operation. The grubbing tools were made as shown at *A* in Fig. 4. It is evident at a glance that if a tool of this shape is given a motion of about a third of a circle, backward and forward, on its center, and a piece of metal is pushed up against it, it will dig a hole into the metal. The bottom of the hole will be a semicircle. Furthermore, it would not have to cut like a fiddle-bow drill, which must be ground only to scrape always, or to cut half the time and drag the other half; but, on the contrary, the tool presented the front edge of cutting teeth to the advancing work. This cutter might have had

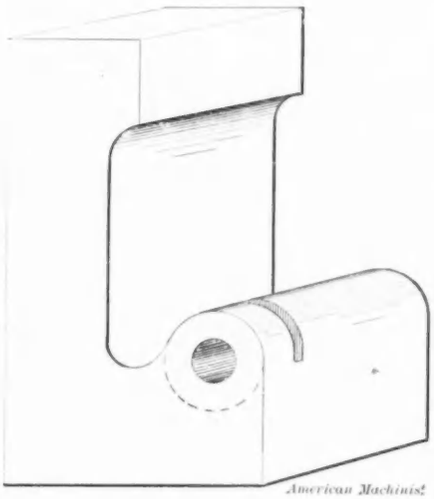

Fig. 8

VARIOUS SEMI-CYLINDRICAL WORK

eight teeth a twelfth of the circumference apart, leaving a third of the circumference for the shank, and each tooth would do its share of cutting as faithfully as if it was on a continuously revolving cutter, or if it was desirable to obtain more clearance for chips, the two-thirds of the circumference available for teeth might have been divided between six teeth, with equal advantage, as shown in the cut. To avoid a multiplicity of engravings, the attempt is made to show the different positions in which the cutter would stand, in relation to the upper surface of the piece, by indicating the surface by dotted lines. The dotted line *B B*, Fig. 4, shows the tool

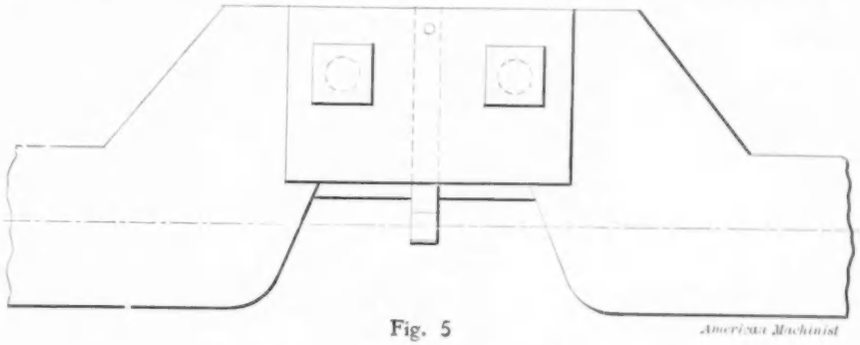

Fig. 5

Fig. 6

Fig. 7

at the end of the backward motion of the crank, which has moved the front teeth forward; they have taken their cut, brought out their chips, and are now ready to be brushed clean, or flooded to remove the chips. The back teeth are in position to be forced into the work to take out their chips with the reverse motion. Now, taking the dotted line *C C* for the surface, the back teeth may be seen clear of the work after taking the back cut. It may be observed that there is no necessity of crowding the work against the back sides of the teeth, but if the feed is given at the opportune moment it will be against the front edge of the teeth.

The form of tool being determined upon, the next step was to give it the correct motion. For this purpose a steel yoke was made something like a crank (see plan Fig. 4 and section, Fig. 5), and the shank of the tool was attached to the arm of the crank in such a position that the center of the tool coincided with the center of the crank shaft, therefore, when the crank shaft made a revolution or any part of a revolution, upon its center, the tool made a corresponding motion upon its corresponding center. The use of this crank shaft transferred the function of maintaining the axis of rotation from the tool centers to the shaft centers, and as these could be positioned at any required distance, by lengthening the arm of the crank, the axis of motion would be unchanged

whatever might be the size of the piece to be operated upon, which might be placed between the centers.

In this instance the crank arm was long enough to allow the pistol frame to pass under it, and the shaft was hung on the centers of a lathe which was utilized for the job. A suitable crank on the counter shaft overhead gave the required motion to it by means of a pitman connected to a lever fastened to one end of the grubbing-crank. This gave it a reciprocating rotary motion of one-third of a circle.

The fixture for holding the pistol frame was attached to the tool carriage of the lathe, which was made fast to the bed in the right place, and the work was moved back and forth to the cutter by the cross-feed screw. The whole arrangement worked satisfactorily, and there was no difficulty about making the cuts so that they were practically alike. The grubbing cutters were all made to gage, and the conditions of interchangeable work were fully met. A hand tool, made in a similar manner, but with a center hole the size of the hinge pin, was inserted in each one and worked, with a pin passed through, to justify them before case-hardening.

A job somewhat similar to that already described, was making the joints for some wrought iron vises of peculiar construction, made for use under triphammers, which are shown unharnessed, front and side view, in Figs. 6 and 7. They were 10 inches high by 6 inches square on the base. It was necessary that the joint should have a full bearing so that the pounding of the triphammer on top of the dies should have the support, not only of the pin, but also of the full face of the joint, to prevent the limber leg from being driven down and getting the dies out of match. In fact, the joint had to be close, to keep out the scale which was continually falling on it, and substantial enough to resist the blow of the hammer.

The forged block was solid as shown in Fig. 8. To finish it, the bottom and sides were planed, and the pin-hole located. The block was then bolted to the face plate of a lathe, and balanced, and the pin-hole drilled, and bored out nearly to finished size. A half-inch cut was then made by the planer through the joint (see Fig. 8), a little more than the thickness of the lug —say an inch and three-eighths—from the side, and to a little below the center of the hole. As the pin-hole was an inch in diameter, advantage could be taken of this circumstance to use a boring-bar. The block was bolted to the tool carriage of a lathe in such a position that a boring-bar inserted in the pin-hole was centered on the centers of the lathe. A little judicious use of the chisel in the slot made by the planer, made a clearance to start a cutter. The cutter was then set and keyed in, and the feed of the lathe carried the cut it made as far as it required to go to leave the lug, on the other end, of the right thickness. In this way, by using longer cutters as they were needed, the hole was enlarged to the required size, 2½ inches. The sides of the lugs were then correctly faced off with properly shaped cutters in the boring-bar. A mandrel was then inserted in the hole and the joint planed off on centers. The job was satisfactorily finished in every respect; and the vises endured a great amount of hard hammering, without causing trouble in the adjustment of the dies.

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Repairs of Electrical Machinery—Field Coils—II.

BY A. R. HARRIS.

In the first article upon this subject it was shown how to repair, temporarily as well as permanently, field coils that are series-wound; in this article we will give some suggestions that will be of service in connection with shunt coils.

Series coils are liable to injury through being struck by falling objects, or by being overheated by an excessive current. Shunt coils are liable to be damaged in the same manner, and it may be added for both that they are also liable to be destroyed if the machine is not kept clean, as under such conditions the oil that will surely work its way from the bearings to the coils will in time soak through the insulation, carrying with it, more or less, metallic dust, and this will form a path through which the current will leak, slowly at first, but rapidly increasing, until it will become strong enough to burn the insulation and establish a short circuit. If the leak is between parts of the coil separated by a large proportion of the total number of turns, which is more than likely to be the case, the burning capacity of the current passing through the short circuit will be so great that the wire in its vicinity will be fused, and so much damage will be done that it will necessitate the removal of a considerable portion of the coil. From this it can be seen that it is very necessary to exercise the greatest care to keep the machine clean, for its life depends upon cleanliness more than that of any other kind of machinery. Do not suppose that because the bearings are far removed from the coil, and there is no apparent possibility of the oil reaching the latter, that it never will, for in this you will be mistaken. Oil has a wonderful way of creeping over surfaces, and the only sure way to prevent it is by attention to cleanliness.

Shunt coils are not so liable to burn out by an excessive current as are series coils, owing to the fact that the action of the machine is such that there is very little danger of the pressure of the current increasing above the normal, and if the machine is properly proportioned it will not become overheated unless the pressure rises above that for which it is intended. It sometimes happens, however, that a dynamo does not give as high pressure as is desired, and to enable it to do so the speed is increased; then, in consequence of the increased speed and increased pressure, the flow of current through the shunt coils becomes greater, and may rise to a point that is beyond the carrying capacity of the wire. Then the latter becomes overheated, and the insulation gives out through becoming charred. From this is will be realized that it is not wise to undertake to force a machine beyond its capacity, unless the experiment is made very carefully, and its effect, as far as heating the field coils is concerned, is accurately noted.

What has been said of a generator, in the foregoing, is true also of a motor, the only difference being, that, to burn out the field coils of the latter, it is necessary to use a current of higher pressure than the motor is intended for; that is, in the generator the damage is done by an increase in speed, and in the motor by an increase in pressure. It very often happens that a man has a motor wound for 220 volts, and tries to run it on a 250-volt current. If the wire on the field is liberally proportioned, no damage will be done, but in most cases the reverse would be the result.

If a shunt coil becomes overheated to such an extent that the insulation becomes charred, there is no way of repairing the damage except by taking off the wire and putting on new. When this has to be done, the course to pursue will depend, to some extent, upon the design of the machine. If it has two or more coils, it will be necessary to rewind the burned-out one with wire of the same size as that that was formerly on it, and with the same number of turns; but if there is but one coil, it may be possible to rewind it with larger wire, and this will be the proper course to pursue, if it is practicable; if not, the next best thing to do is to use the same size wire, but a greater number of turns. To make this point clear, an explanation will be necessary.

Suppose the machine is wound for 220 volts, and that it has only one coil on the field, and that this is of No. 20 B. & S. gage, and has a resistance of 220 ohms, which will allow a current of one ampere to pass through it; then the magnetizing force of this current will be equal to one ampere running through about 21,560 feet of wire, as that is the number of feet in 220 ohms of No. 20 wire. If the average length of a turn is two feet, there will be 10,780 turns, and as the current is one ampere this figure will also represent the number of ampere turns. If the wire is made shorter, the number of ampere turns will not be increased or decreased, but the current will be increased, and therefore the heat developed in the coil will be more, and as a result it will become hotter. If the length of the wire is increased the ampere turns will still remain the same, but the current will be decreased, and therefore the heat developed will be less and the coils will keep cooler. That

this is the case can be made clearer by the following figures:

Suppose the length of the wire is reduced to one-half, then the resistance will be one-half, and the current will be doubled. Now, the heating effect is in direct proportion to the current strength multiplied by the voltage; hence, in the first case we would have 220 volts × 1 ampere = 220 watts, the watt being the unit that measures the heating effect. In the second case we would have 220 volts × 2 amperes = 400 watts, or twice as much. In the same way it can be shown that if the wire is doubled the current will be halved, and the heat developed will be reduced to one-half. Now as to the magnetizing effect, we can show in an equally simple manner that it will remain the same whether the wire is longer or shorter. To illustrate this point, suppose the length is reduced to one-half; then it is evident that the number of turns will be reduced to one-half, but the current flowing through the wire has been increased to double its former strength, as shown above; hence, the number of ampere turns remains the same, as in one case we have 10,780 turns of wire × 1 ampere = 10,780 ampere turns, and in the second case 5,390 turns of wire × 2 amperes = 10,780 ampere turns. If the wire is doubled in length the same result will be obtained. The equality of the magnetizing effect of a large or small number of turns of wire of the same size is strictly true only upon the assumption that all the turns on the coil are of the same length, and therefore would only hold good in practice if the coil were so long that all the wire could be placed in one layer. This cannot be done, however, and therefore, as the turns in each succeeding layer are a trifle longer than those in the under coils, it follows that as the wire is shortened the magnetizing effect of it will slightly increase, but the increase will be very small, especially in coils of large diameter; so that, for all practical purposes, we can say that the magnetizing effect of a given size wire is the same so long as the pressure of the current remains unchanged and is not affected by increasing or decreasing the number of turns. This being the case, it follows that, whatever size wire is used, the greater the number of turns the better, as thereby the heat developed will be reduced, and the magnetizing effect will not. It was on this account that it was stated above, that if larger wire cannot be used, the next best procedure is to put on more wire of the same size.

If the size of the wire is increased, a greater magnetizing force can be obtained with a still smaller development of heat, providing there is room for sufficient wire to cut down the current by an adequate increase in the resistance. If the wire is No. 19, the ampere turns will be increased by about 23 per cent., and to keep the current down to the same strength it would be necessary to wind on to the coils that amount of additional turns. By using a resistance in the field coil circuit, the current could be cut down to a point where the magnetizing force would be the same as with the No. 20 wire, and the total current use for the field would be less than with the smaller wire, notwithstanding that a portion of it would be going to waste in the outside resistance. In addition to this saving in amount, the coil would remain much cooler.

If there is room for still more wire in the coil, by adding it the current can be cut down further, the heat developed can be further reduced, and a further saving in the energy required to magnetize the field can be made. If the machine is a generator, and its speed can be reduced, a portion of the external resistance can be done away with, and the same result can be accomplished with a motor, if there is no objection to its running slower.

The space occupied by a wire even one size larger is so much more, that in most cases it will be found impracticable to use a larger size, but there are few cases where more turns of the same size cannot be put on. The manufacturers do not always put on all that is possible, as it would increase the cost of the machine, and therefore they stop at a point that will reduce the current sufficiently to afford a good efficiency for a machine of the size, and that will reduce the heat developed to such an extent as to render burn-outs practically impossible, with a pressure not above that for which the machine is designed.

If the machine has more than one coil, from what has been said it will be easily seen that it would not be permissible to depart from the regular construction, as, by so doing, the repaired coil would be made to predominate over the others, and thus throw the field out of balance and cause serious, if not fatal, sparking at the brushes. A little reflection will show that this is so. Suppose the same size of wire was used, and that the number of turns were increased; then, as the same current would pass through all the coils, the repaired one would have the greater number of ampere turns, and therefore would magnetize its part of the field the strongest, and the other coils would be weaker than before, owing to the fact that the extra wire added to the coil would increase the total resistance, and thus cut down the current to a point lower than it formerly was. The sum total of all the magnetizing force acting upon the field would remain the same, but it would not be divided equally; the rewound coil would get more than its share, and the old ones less.

To sum up, it may be said, that if a machine has one coil upon the field, and that burns out, it can be replaced with a new one of the same size wire with a greater number of turns, if there is space for more wire, and that the effect of such a procedure will be beneficial, as it will cause the coil to keep cooler than its predecessor. If there is an abundance of room, sufficient to wind on a great many more turns of a size larger wire, it would be advisable to use such, providing a reduction in speed is not objectionable, or that you are provided with a resistance that can be placed in circuit with the field so as to cut down the current, and thus maintain the velocity unchanged. If the machine has more than one coil, the rewinding should be done with wire of the same size as that with which it was wound in the first instance, and the number of turns should be made practically the same. It should not be inferred from any of the foregoing that the number of turns in all the coils must be exactly the same, for this is not the case; a slight deviation from equality will not produce noticeable effects, and, in fact, even a difference as great as five per cent. would not be serious with most machines, but it would be with some; therefore, an effort should be made to come as near to equality as possible, say within one or two per cent.

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Laying Up Steam-Heating Plants.

BY W. H. WAKEMAN.

As the time approaches when steam will not be needed for several months, it will be profitable to give some attention to the matter of caring for the boilers and appliances which must remain out of use during the warm weather, in order that the same may be found in good order when again wanted for use. I am prompted to write this article by observing the failure of some men in charge of these plants to take necessary precautions to this end, and by inquiries on the same subject. As warm weather gradually approaches, some of the boilers in large plants are laid off for a time; but as it is possible that they may be needed again for a few days, it will not answer to put them out of service permanently; therefore they may be left full of water, and all ready to be fired up. The objection to this is that where the water can be heated by radiation from other boilers, it sometimes causes pitting, which proves very destructive to boilers not in use; therefore it is much better to empty a boiler that is not to be used for a week or two, and fill it up with fresh water when required. Care should be taken to have all valves in connecting pipes perfectly tight, or else the steam and water from those under pressure will cause the idle boiler to rust badly.

When warm weather has fully come, and it is morally certain that heat will not be required for several months, the engineer should give the boilers special care, for it is an old saying that "boilers deteriorate faster when idle than when in

use," which is not necessarily true in all cases, although it unfortunately is in many of them. The practice of filling these boilers full of water, and allowing them to stand all summer in this condition, is not as commonly practiced as formerly, which is a move in the right direction; but if any still prefer this plan, care should be taken to boil the water before leaving it, in order to expel the air, because this will remove one of the principal causes of rust and corrosion.

It is undoubtedly a much better plan to entirely remove the water, take out the man and hand hole covers, and allow the air to freely circulate through the boiler. One advantage of this is, that if rust does begin to collect, it may be discovered at once before it has done much damage. If boilers are located in damp cellars, it will be well to give the internal parts a coating of kerosene or crude petroleum; but too much care cannot be taken about bringing fire where it can reach the inflammable gases which arise from all such oils, for several accidents have already occurred from this cause, and probably more will in the future, to those boiler attendants who do not read the mechanical papers.

Where there is a coating of scale on such boilers in the spring, much of it will be loosened and detached before cold weather arrives again, for the oil will work in between the scale and the iron, producing this most desirable result. Cast-iron receivers are frequently used in connection with duplex pumps, for collecting and removing the water of condensation from the heating systems, and the water should be thoroughly drained out of these, and while the receiver needs no further attention after it is cleaned out, the pump should not be neglected. The cylinder heads should be taken off, the packing removed from the water pistons and the stuffing boxes, the cylinders and rods covered with cylinder oil, and if there is some graphite mixed with it there will be no harm done. The steam-chest covers should also be removed, and the steam valves and their seats thoroughly covered with this mixture. If injectors are used they should be disconnected and filled with kerosene oil, after all outlets but one have been plugged. This will not only prevent the accumulation of scale, but will remove any that may have already collected. Radiator valves should be opened to prevent any possible corrosion of their seats, but, as a rule, air valves will need no attention, because they are supposed to be so adjusted that they are not forced to their seats when the plant is cooled off. Damper regulators should be disconnected, dried and cleaned, and all other appliances should receive due attention to prevent deterioration, for it is considered that even such machinery depreciates faster when idle than when in use; but there is no good reason why this should always be so. It seems hardly possible that any person could be found who would shut a steam-heating plant down and leave it all summer, just as he would leave it for one night, and yet such cases are not unknown. A due attention to the foregoing suggestions will prevent undue depreciation of machinery, and save trouble for whoever must start up and operate the plant the next season.

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Letters from Practical Men.

First-Class Mechanics.

Editor American Machinist:

Your discussion of the "five first-class mechanics," of Worcester, opens up an interesting question upon which your editorials on the above subject touch only by implication. It seems as if the whole point of the discussion hangs upon the question, What is a first-class mechanic? As the first requirement of any mechanism is efficiency, it would seem that he who might be able to construct a mechanism of the highest efficiency might be considered "first-class" in that line.

But what is efficiency? It is the capacity to do the work. Suppose that work to be recording distances so minute or within such limits as to be far beyond any unaided sense perception; the mechanism employed must be the most accurate obtainable. Or suppose it to be the investigation of distances and masses the measures of which are limited only by the universe; here again the nature of the problem demands the greatest possible precision.

But, again, suppose the end to be attained is the drawing of heavy trains at high speed over steep grades, around sharp curves, and upon dusty road-beds; here we must not look for close fits and fine measurements, and the mechanic who would make a main journal or a crank-pin box with no shake anywhere would be as bad as he who would build a dividing engine with a two-foot rule.

Take, again, some wood-working machine that runs half buried in saw-dust; its long-toothed, cast gears, and its rough studs secured by cotter pins show no mark of refinement. But place your magnificent equatorial upon a railroad train, or your comparator in a saw-dust heap, and what would be its readings?

Does the violinist who holds his audience spellbound by the delicacy and magic of his skill and the fine interpretation of the composer show himself less worthy of the name of master because he cannot play the organ? Or does the organist who moves his hearers to his will by his grand rendition of one of the old masters deserve the slurs of the critic because he cannot produce a tone on a violin? Human endowment is too limited and life is too short for one man to master all instruments.

And so, on the one hand, take that mechanic who has devoted his life to building the rough and dirty locomotive, who knows his work and its demands from A to Z, who knows how to build an engine that fulfils its requirements and causes the world to wonder, and whose hands have grown hard and knotty in the handling of heavy masses; and, on the other hand, take that delicate workman whose wonderful accuracy, obtained only by years of training, enables him to produce those mechanisms by aid of which the infinitesimal becomes the finite to our senses. Shall the former, with his habit of thought fixed by long years with the tons and large dimensions he has handled, be expected to deal with the delicate parts and small decimals of the latter? Or shall the latter, who has grown to regard a thousandth of an inch as a large hole, be expected to deal successfully with the tons of the former? Surely, the same general principles underlie the work of both, but does not he who expects further correspondence than in principles only, show by that expectation how poor is his mental grasp of the requirements, the results, and the evironment of those of whom he claims to speak?

Here are my respects to the intellect that could, by the assemblage of rough castings, cut the grain, bundle the sheaf, and tie the knot. I take off my hat to the man whose wonderful product passes the needle back and forth and forms the stitch that unites two pieces of cloth. And he who builds the enormous boiler of the modern ocean mail steamer is the peer of him who makes the beautiful and jeweled watch that keeps a check upon the accuracy of the sun.

The high class of work of to-day is not a mushroom growth, but the evolution of years of hard earned and dearly bought experience, and if a mechanic finds upon his hands, a piece of work demanding the utmost knowledge that the world can supply, he shows only his narrowness and utter unfitness to cope with the problem if he does not, by travel or correspondence and study, acquaint himself with all that has been done both here and abroad in any direction bearing upon that subject.

FREDERICK M. BUSH,
Constructor of Scientific Instruments and Laboratory Apparatus.
Rochester, N. Y.

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Mathematician vs. the Constructor as a Student.

Editor American Machinist:

The discussion opened by Professor Hutton interests us. We have long been confronted with the difficulty which perplexes him. We are far from believing that we have solved it, yet substantial progress has been made. Experience supports the belief that much valuable engineering training can be given before the student takes up calculus and analytical mechanics, and our courses have frequently been recast with this idea in view. Drawing, shopwork, properties of materials, and the major part of physical laboratory practice, are all open to such

men. We believe that other subjects under our direction can be added to this list in the near future. Further, it seems to us that all through his course, the student should see and work with the material thing itself before attempting a mathematical discussion of it. For example, the descriptive study of the steam engine, supplemented with some practical laboratory work, should precede instruction in thermodynamics, kinematics of valve-gears, etc. We are endeavoring to give all our instruction on this basis, and are encouraged by the fact that others, like Professor Hutton, find this the most efficient method.

Yet one thing seems to us incontestable—the craftsman's experience, dexterity, and mechanical intuition cannot supplant skill in mathematical analysis. The latter is getting to a greater degree a necessity as engineering becomes a more exact science and competition enforces closer economy. Hence, it seems to us the main issue is—What mathematics should the engineering student be taught, and how should he be taught it?

The attempt to "teach men to think" by pitching them headlong into a lot of mathematics, of value for no other purpose, has, in our judgment, been greatly overdone. Any subject which cannot be justified on the ground that it has an actual and vital bearing on the student's progress in acquiring engineering, has no place in an engineering school. Spherical trigonometry will, no doubt, sharpen the wits of the embryo mechanical engineer; so will Sanscrit; neither, however, can do this so well as more exhaustive study and practical applications of some subject an engineer will use all his life. Any scheme "to train men to think" in which the thing thought about is valueless in itself certainly seems ill-advised.

We cannot admit that because so many students fail in mathematics it therefore follows that this subject is, *per se*, more difficult than others belonging to an engineering course. The method of teaching mathematics is, in our judgment, responsible for most of the trouble. We have reason to think that in the vast majority of cases mathematics are taught from the standpoint of mental gymnastics, and that very little attempt is made so to present the subject that the student is early able to answer to his satisfaction the question, "What is all this stuff good for." The instruction should partake more of the spirit of laboratory teaching. The student should be constantly drilled in practical applications, and, so far as circumstances permit, he should never have explained to him a new principle, until, by trying to solve some practical problem, he has been brought face to face with the necessity for the new truth which is to be unfolded to him. Such teaching can best be done by giving at an early stage of the course some practical engineering instruction, and then drawing on this for problems to illustrate the mathematical courses. It is principally because they can supply such illustrations for themselves that "the most enthusiastic class of students . . . are those who have had a previous experience in the shop or in the power house, which has made them familiar with the conditions which there prevail, and has brought to their attention questions for which they have sought to find answers." From first to last, mathematics should be talked of and handled merely as one of the necessary tools the engineer is acquiring for his future work, and, like a shop tool, its value should be determined by testing it on some material the engineer actually uses.

For example, we think geometry would lose many of its 15-puzzle characteristics and give the student far more real knowledge than is now usual, were drawing-board exercises made an essential feature of the study. From their very start, calculus and analytical mechanics can be illustrated in an infinite number of ways by practical exercises which have a live meaning to the engineering student. One taught in this way quickly realizes what the subject is good for, and he likewise grasps the difference between the exact conditions of abstract mathematical problems, and the approximate solutions almost invariably demanded in practice, because of lack of complete data, or the impossibility of effecting a solution if all of them are taken into account. Too little attention is paid to this aspect of the subject even by engineering professors. To illustrate, there lies before us a prominent text-book; it assumes as a basis the theoretical sharp-cornered indicator diagram whose curves are equilateral hyperbolas, and it bristles with integrals and abstruse mathematical deductions, the object of which is to determine the proper cylinder ratios and points of cut-off in compound engines; results are worked out to several decimal places, in utter disregard of the fact that the area of the assumed diagram falls short of the one obtained in practice by from 6 to 40 per cent. It is this kind of teaching which is responsible for the fact that the student who shines in mathematics at school frequently fails in practice. Such teaching probably does train men to think, but not in the way an engineer must think; it develops a certain kind of analytical skill, but not engineering "gumption." Teach the student to apply his knowledge with accuracy and good judgment, and "learning to think" will take care of itself.

We are fully conscious of the extra burden such teaching puts upon the instructor. It is not necessary that the teacher of mathematics be an engineer, but he must have the engineering instinct or his instruction will be a failure. Textbooks adapted to his use are few—if, indeed, they exist at all. Yet we believe that the appearance of such books is only a matter of time, and a short time.

Professor Hutton did not state, and perhaps does not realize, that the objection he urges against the mathematical test applies with equal force to every other subject. Students of marked ability in mathematics are frequently shut out by failure to pass in other studies; they have exactly the same right to complain against these studies that other men have against mathematics. This difficulty will ever exist so long as courses are planned without reference to the individual peculiarities of the men who are to follow them. It is inevitable either that good students must be dropped out altogether, or else be reported as passed in some subjects which they did not and never can master, because of lack of ability in that particular direction. It is this which leads us to believe that a thoroughly worked out and properly guarded elective system is the most efficient one in an engineering school. It seems, indeed, the only one under which drones can be cast out, and good men pursue studies along lines in harmony with their capacity. We venture the assertion that the greatest defect in most educational schemes is the failure to recognize the enormous waste of energy, time and money consequent on trying to impart knowledge without any regard to whether Nature has fitted the student to receive it. Such attempts are usually failures. Nature wins every time. Not all the attractions of luxury and a life of ease were able to restrain Achilles when he found the sword concealed in the basket of women's finery. It is questionable, however, whether he would have accomplished much with that sword, had he been compelled to wear the feminine trumpery along with it. We cannot help feeling that similar reasoning applies in the case of many subjects obligatory on students who follow rigid engineering courses.

EDGAR KIDWELL,
Prof. Mech. Eng.
F. W. MCNAIR,
Prof. Mathematics.
Michigan College of Mines, Houghton, Mich.

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Assembling Machines Without Oil.

Editor American Machinist:

The very first paragraph in the "American Machinist" of March 18th calls my attention to what I think a rather important machine-shop topic. And it calls my attention to it by the simple fact of not alluding to it at all. In this case it was not a sin of omission, however, and I am not, as usual, fault-finding, but rather thanking Mr. Freeland for the opportunity that he opens up. He tells us of the chips and things that are sometimes left in out of the way and inaccessible (after the machine is finished) parts of "cheap" machines. Such things are often found on machines that are not so cheap;

but they always, when discovered, speak loudly of negligence somewhere, or of oversight which overlooks.

Mr. Freeland then tells of the hot soda-water bath that the parts of machines are treated to in a certain establishment, whereby they are rendered clean as a hound's tooth and dry as a bone, before they are put together. Then comes in my query of, What next? With the parts all in this nude condition, how are they treated after that? I wonder if every part of every machine is conscientiously oiled before its final and permanent association with every neighboring port.

The action of oil, good oil, in connection with machinery, to the minutest detail of it, seems to be almost entirely a beneficent one. It does a power of good in nearly every case, and who can say where it ever did harm? There is little occasion ever to question the propriety, if not the necessity, of oiling any part, active or passive, of a machine, and when in doubt, give the part the benefit of the doubt, and the benefit of the oil every time.

At one time or another I have had to do with a great many new tools. I have had anything but an all-around pleasant experience with them. I have learned to distrust them, and to handle them with great caution, because I know that they are quite likely to get a fellow into a scrape. The cause of trouble with new machines more frequently than any other, or perhaps than all others, is in the neglect of properly oiling every part as it is put together.

Workmen are generally reasonably careful and conscientious about wiping clean the working parts, or, in fact, all parts, of machines that they are assembling, but they are far from being as careful about oiling every part. It is the simplest truism to say that every stud, or every cap screw or set screw, every nut, both the thread and the face upon which it bears, should be oiled when put in place; but it would be a difficult task to prove to me that this is done more than a quarter of the time. The working parts, the journals, and the slides and such things, are probably more frequently oiled, say one-half the time, but that they are not all oiled at the assembling as they should be, I know to my sorrow. I have had bearings so dry that when oiled and started up, the oil would not flow over and wet the surfaces quick enough to prevent serious cutting and heating, and, in solid boxes, seizing, before the oil could get there. It is by no means every machinist that looks upon oil as essentially a part of every machine. It is too often an afterthought when the machine won't go. The afterthought should be in every case the forethought, both for the good and the safety of the machine and for the reputation of the machinist.

TECUMSEH SWIFT.

Requirements for Rapid and Accurate Grinding.

Editor American Machinist:

I note with interest the remarks of Mr. Randol, in your issue of February 25th, on the subject of "The use of the grinding Machine," and I fully concur with him in his views upon what is necessary to produce good work in grinding.

I strongly advocate the abundant use of water to do the work accurately and rapidly. My experience some years ago indelibly fixed this requirement on my mind, as will be seen by reference to an article by me in the "American Machinist" of September 29, 1888, in which I explained the action of a shaft while grinding, and upon which some water was used, but not in sufficient quantity. The change of temperature caused the shaft to weave back and forth, cutting once upon one side then upon the other, and never making true nor round work; but the abundant supply of water removed all difficulties, and the work was rapidly executed.

I have been following the matter of grinding along these lines ever since, and have found that it is the only correct way to do all kinds of work rapidly and accurately, whether grinding shafts, cones, disks, sides of cutters or saws, or grinding out holes. The general practice, however, has been to grind dry, and I think this arises from the fact that the merits of the free use of water are not looked into by many of the operators of grinding machines, and many probably are deterred from using water from the inadaptability for the free use of water in the machine they may be using. With the lack of knowledge of the great advantages attained by keeping the work cool,, grinding has continued in a tedious and slow manner, which is invariably the case in dry grinding, causing many manufacturers of machinery to look upon grinding of detail parts of machinery as of no commercial value, but rather as an expensive luxury and not allowable in these days of competition. To their minds its only value is to grind work which has been hardened. This is a mistake. Grinding done in the proper manner, with the free use of water and a properly constructed machine, will not only finish work of this kind cheaper, but will make it far more perfect. It is, however, worthy of note that this prejudice against the grinding machine is growing less every day.

Aside from the abundant use of water in all grinding operations, there are other conditions necessary to get good results. The head and foot stocks, as well as the emery wheel base or stand, should be made very heavy, so as to avoid any vibration of either of these—on the anvil principle. All the sliding surfaces, such as wheel slide and the ways, should be accurately fitted, and the surfaces of the table and the head and foot stock should be fitted to a solid bearing, so that when they are clamped they will be solid; the emery-wheel spindle and the head and foot stock spindles should be well fitted, and adjusted as closely as possible. In addition, the machine must have the frame or bed of sufficient weight and stiffness, so that even if an imperfect bearing of the same upon the floor or foundation should exist, it shall have no influence upon the accuracy of the grinding. This reminds me of what was told me by a mechanical engineer some time ago; he was speaking of the delicacy of grinding and that it detects the least variations. He said he visited a shop where considerable grinding was done and regularly manufactured machines were employed, and there saw a machine taking a cut on a shaft showing decided sparks while he was standing in front of the machine; when he walked around to the rear side it stopped the grinding, and returning to the front would grind again. This indeed did illustrate something at least.

The free use of water on a grinding machine will rarely be adopted by operators, if the construction of the machine is not adapted for it; that is, to carry all the water away in a proper course. I have asked persons who were grinding dry, why they did not use water. They replied that they did not like the water slopping about everywhere, and therefore they preferred the dry operation. This prevented the execution of rapid and accurate work, probably unconsciously to the operator and the employer as well, and thereby discredited this excellent method of finishing parts.

If all manufacturers of machinery of whatever kind, would carefully investigate the merits of grinding the shafts, spindles, studs, bushings, etc., employed in their products, as it can be done upon machines having the requirements for executing the work rapidly and accurately, many if not all of them who now deem such methods of finishing as out of the question, would become converts to grinding, and would not think of dispensing with such machines.

A. B. LANDIS.

Waynesboro, Pa.

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Hints on Machine Photography.

Editor American Machinist:

I will try to give you my ideas as to how a photo of a machine should be made. My rule is to use only one brand of dry plate, the Cramer "Banner," and I use Eskonayer developer, the formula that comes with the plates. I do not believe in quick development, but take plenty of time and use a very weak developer. I also give a very long exposure, which, however, depends upon the time of day. I like a cloudy day and about 10 A. M., as I think the light is better at that time. I use Vaightlander and Steinheil lenses of long focus, as with the long focus we have less distortion and yet a truer perspective.

Most machine firms make a mistake in

not having their machines properly painted for photographing. A dead color should be used and very dark, for that brings out the finished parts better. The painter should be careful and not cross his paint lines, as they will show and make the casting look as if cast in sections. I always use a white ground and avoid over exposure, as that would make it come out dark instead of light.

I do not make any claim to be a better photographer than others in the business, but I have had a mechanical education. That is, I was a machinist and tool maker before I went into photography, and that, I think, helps me more than anything else. Common sense and judgment should be used all the while. Do not try to take an instantaneous picture of a machine that ought to have at least thirty seconds exposure.

F. S. OLDS.

Newark, N. J.

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Small Pinion Work.

Editor American Machinist:

Having made a large number of small pinions, or rather cut them from pinion wire, it may be of some interest to know how the pivots on the same were finished.

Let *a*, Fig. 1, show the face of the screw-lathe chuck, and *b* a cutting-rest for the work in the turret-head. The pinion wire then is supported close to the chuck, and near the cuts in the rest *b*. The back-tool is shown at *c* and the front-tool at *d*. These tools are planed or milled up in strips as shown in profile, and made to fit rigid holders, provided with a strong holding device. They can be ground on the face for sharpening, and adjust up and down in the holder which holds them at an angle

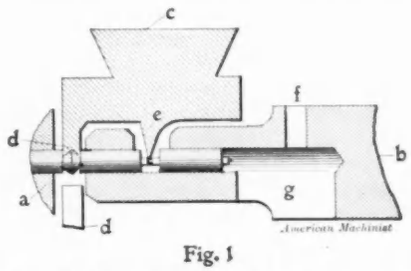

Fig. 1

TOOLS FOR CUTTING OFF PINION WIRE.

to give clearance. So they never change in shape.

The tool *c* is V-shaped at *d* to avoid breaking down the leaves of the pinion either side of the cut by entering full width; and *d* follows to cut the center out for the straight shape.

The cut-off at *e* must be started right, by having the stop in the turret-head arranged properly, or one pinion will come short and one long alternately.

The outlet for the work is shown at *f* and *g*, only the opening should be a quarter way around the piece *b*, and open downwards instead of at the side, as shown in the sketch. The opening at *f* allows of pushing any piece out through *g* if necessary.

While the tool *c*, Fig. 1, may be kept very sharp and set carefully, the work when done will appear more or less as seen at *a*, Fig. 2, having a point and a burr on the corner. The pivots on this lot of pinions were six one-hundredths in diameter and three long, and could not be finished to good advantage in the screw lathe.

It would be pretty slow work to hold the pinions in any kind of a chuck by each end and file the same, besides requiring some skill to preserve their shape. So I purchased a little brush-stand, or rather four for a dollar apiece, and used two for countershafts; and the others for this and some other work.

Putting an emery-wheel *b* on the screw-arbor end of the stand, I secured the piece *c* in the end of the same, and dressed the corners of pivots off as shown.

I made the little hollow mill or file with a tool like *d*, shown in section at *e*. After drilling the hole in *c* and countersinking it with *d*, the same was used as a chisel to cut the file teeth as seen at *e*.

The pinion is held in the finger and the point ground off on *b*, and the corner filed off by *c*, on one end and then on the other.

I intended to make several of these little mills, but delayed doing so, and find, after cutting 20,000, that the tool seems all right yet. A. H. CLEAVES.

Chicago, Ill.

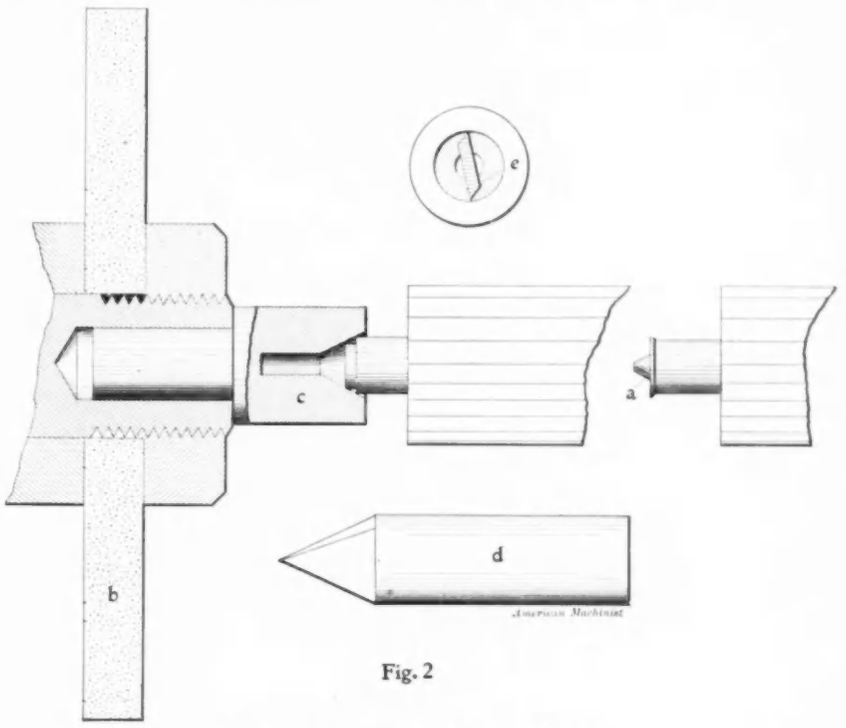

Fig. 2

TOOLS FOR REMOVING BURRS.

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The Advantage of Fine Threads.

Editor American Machinist:

Here is something I think too good to keep: The other day a bicycle salesman, in telling me of the good points of his wheel, called particular attention to the fine threads used on the ball cups. "You see, the parts of our shaft and hanger are easily assembled" (putting them rapidly together). "The threads on these ball cups are cut very fine pitch, so they screw in about square. You understand if they were coarse pitch they would stand at quite an angle; but the fine threads we use run nearly straight around, so they go in about square." I was startled. The bicycle business seems to be developing some pretty bright ideas.

A MECHANIC.

Providence, R. I.

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"No other one condition is so destructive to good economy as an engine overlarge for its work. A large engine working with an extremely light load is worse than a small business with a large staff of expensive officers. A small engine overloaded may be an annoyance and care, but if in good condition it may be economical in fuel."—Le Van.

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The following question and answer from a British contemporary strike us as decidedly queer:

"Could any reader inform me how much larger I should turn a crank pin—size of head 7¼ inches x 8 inches long; the crank to be heated and shrunk on the pin?—S. S.

"Answer—I would advise S. S. not to make his crank pin any more than 3-32 inch larger than the crank hole if it is a wrought-iron one but if it is a metal one, 1-32 inch is ample, as it takes very little to burst one of metal.—H. L."

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The Proper Line of Action for the Opponents of the Metric System.

We cannot but think that those who are laboring to prevent the compulsory adoption of the metric system in this country are taking an unwise method of accomplishing their object. We have touched upon this topic before, but it will bear further discussion.

In our opinion a large proportion of the arguments advanced on both sides of this question are simply moonshine, and in so far as arguments of that kind are adduced by the opponents of the system, their effect is to befog the real issue and weaken the case. We consider, for example, that the elaborate paper by Mr. Colles before the December meeting of the American Society of Mechanical Engineers is largely inconsequential, many of its arguments having no bearing upon the real merits of the question.

In particular, we regard arguments against the abstract merits of the system as worse than wasted, for the reason that, whatever the facts may be, the opponents of the system are on this view of the matter hopelessly outvoted—not by the public at large on a true popular vote, for there is no such vote, but by those who are heard through the press and before Congressional committees. It is idle to deny that the great majority of scientific men and of scientific societies are committed to the advantages of the system, and it is they who are making all the noise, about the only organized opposition to which in this country is through the American Society of Mechanical Engineers. In such a case it is not to be expected that a Congressional committee should discriminate in weighing the force of testimony, or that it could do it intelligently if so disposed. When a hundred men testify on one side to one on the other, the majority will ordinarily win, as a matter of course, especially when they occupy positions such as to command respect.

What then shall be done? In our opinion the claims of its advocates as to the abstract merits of the system should be freely admitted, but it should be pointed out that when admitted they promise but a small recompense for the cost of the change. Let it be admitted that when it comes to calculating the weight of a tank of water, the metric system has the advantage; but then let it be shown how small a proportion of the public ever have this calculation to make, or any other in which such a saving of labor is effected, and that when it comes to the calculation by someone who does need to make it, it is a matter of three minutes' labor by the metric system against five by our own, and that the real gain by the change is a bagatelle. Let the cost of the change be then shown and contrasted against its trifling gain. Let the time required to establish our system of screw threads be shown and its value demonstrated, and let the confusion certain to arise from its being discarded be explained. Let the American system of pipe threads be explained, and its advantage to us in foreign markets be pointed out. Let its effect in cheapening all kinds of repair work be shown, and in connection with this, let the confusion and expense of applying metric conditions to existing work be explained. In other words, let the Congressmen be made to understand that the compulsory use of this system would increase their own plumbers' bills, and while on this subject, let it be made plain that the subject of repairs alone would compel the existence of the two systems side by side for at least half-a-century.

In this connection it should be made plain that the unanimity of scientific men on the subject counts for nothing by reason of the nature of their work. They are constantly in contact with work and calculations of a kind in which the advantages of the system stand out in great prominence, while they have little or no contact with that class of work in which the change would bring about confusion and expense. In other words, their relations to the system are the exact reverse of those engaged in productive enterprises, and lead them to magnify the advantages of the change and to minimize or ignore the disadvantages. The soundness of the views of these men, so far as they relate to their own work, should be admitted; but the fact that they are antagonistic to the interests of the public at large should be insisted upon. The two uses of a system of weights and measures—one for weighing and measuring, and the other for calculations—should be shown, and the fact that it is those whose use of it is largely that of calculation who are publicly heard in the discussion, while the great public who do the weighing and measuring is practically voiceless, which leads to the preponderating weight of published evidence being so one-sided. Finally, if the need of the system to satisfy foreign purchasers of goods is insisted on, let it be shown that that side of the subject can safely be left to individual action. No live manufacturer will fail to adopt the system if necessary to retain his trade, and if this aspect of the case ever assumes importance, the manufacturers can be depended upon to act in accordance with their own interests, just as the scientific men have already done with theirs, and far better than the Government can do it for them.

On these lines we believe the opposition to the compulsory adoption of the system may succeed, but on existing lines we believe it will eventually fail, and are almost prepared to say it deserves to fail.

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The Art of Questioning.

Probably few of our readers have any idea of the number and scope of the questions that continually pour in upon us, or of the labor involved in satisfactorily disposing of them. We certainly do not answer them all, and for at least two very good reasons, one of which is that we do not know enough. This is of course, very much to be regretted, both by ourselves and by those who apply to us. Our second reason is also one to be regarded with little satisfaction, and that is, that we really have not sufficient time which we can properly spare from other duties to look up matters with sufficient thoroughness to enable us to shape unassailable answers. We risk our infallibility continually to preserve friendship, but, as a preservative process, it is not to be commended.

We might offer a third reason—and often the best reason of all—and that is, that in many cases it would be no kindness and little help to the questioner to answer his questions. It has seemed sometimes that we would be actually doing an injury by giving a direct and ex-

plicit answer to a simple question. We can say this freely, notwithstanding that we believe fully in not merely the propriety, but the absolute necessity of continual questioning. We have no respect for the man, and no hope for the future of the man, who does not ask questions. The habit and the art of questioning are essential to all progress and success. The art is vastly important, and, unfortunately, does not go with the habit. All depends upon how and when the questions are asked. No man can carry all knowledge, or even more than a small portion of it; but many men know where and how to find what they want, and when they want it. They have the art of questioning, as far as it applies to knowledge already formulated or recorded. But knowledge so communicated adds nothing directly to the store of the world. The most successful and productive questions are not those which are propounded by spoken or written word by one individual to another. It is the questions that are asked of things rather than of persons, of Nature rather than of man, usually in the guise of investigations or experiments, that bring the answers that enrich the race.

It is well for every man to employ as fully as possible the best and most reliable of all help, which is self-help. In the matter of getting information, independence is much more than the avoidance of reciprocal obligation. Going direct to the common sources of information is quicker and cheaper than any other way. We wish to encourage rather than to discourage intelligent questioning, but we wish also to suggest some thought as to what it is proper to ask of us. A foundry foreman has written to us to know the weight of a cubic foot of molding sand. As he had the sand and the scales beside him, the question would have been a very proper one for us to ask of him; but going in the other direction, it does not pay the freight. It is not necessary just now to give another instance; we trust that our readers will be able to catch the idea.

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Destruction of the Landis Grinding Machine Works by Fire.

We are pained to learn of the destruction of the main shop of the Landis Bros. Works at Waynesboro, Pa., by fire on the morning of April 25th.

These works have been built up from small beginnings by hard and meritorious work, and we feel sure that the sympathy of all our readers will be with Messrs. Landis in their great loss. The works were filled with the finest class of machinery, and work had just been begun on several large orders. Our readers will kindly note the following extract from Landis Bros.' note to this office: "Our catalog file, with all catalogs, was also destroyed, and we would be much pleased to have manufacturers send us their catalogs, as we shall soon be ready to consider the purchase of new tools." We understand there was no insurance.

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Fair of the American Institute.

It is announced that the next annual fair, or "Exhibition of American Art and Industry," of the American Institute is to be held in Madison Square Garden, in this city, from September 20th to November 4th, inclusive. Mr. Alfred Chasseaud is to be managing director. The advance announcement says:

"Mr. Chasseaud is planning to amplify the departments that have become regular features of the American Institute Fairs, and will inaugurate several new departures. The Flower Show, which has proved a good attraction, will in particular be greatly strengthened and extended. There are likely to be innovations in the way of exhibits from foreign manufacturers. Cooking lectures on novel lines will be a feature, and a special effort will be made to secure all possible illustrations of new machinery, inventions, industrial and chemical processes.

"Competitive exhibits on a grand scale of penmanship and drawing from public school pupils is a contemplated phase of the Fair, which will be strictly in line with the traditions and undeviating aim of the American Institute to be a public educational institution of increasing value."

From a mechanical standpoint at least, there has been much to condemn and nothing to commend in recent exhibitions of the American Institute. If there is any hope for a creditable exhibition we will be glad to help it along.

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American Manufactures at the Brussels Exhibition.

The exhibit of American machinery at the Brussels Exposition does not promise to be a very large one, wherein it will not differ from previous European exhibitions. Some of the leading exhibits of American goods will be a comprehensive collection of agricultural machinery and of windmills. Windmills are of such common use in Belgium, and the American mills differ so radically from those used by the Belgians, that it is anticipated the exhibit will attract a great amount of attention. It is understood that cash registers and household furniture will also be exhibited in a creditable manner.

This exhibition returns to the old practice of giving money prizes, a $5,000 capital prize being offered for the exhibit showing the greatest special importance and utility.

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Mr. J. D. Weir, who has been connected with the Ingersoll Milling Company, has accepted a position with F. M. Davis, Denver, Col.

Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(60) C. V. F., Stanton, Ia., asks: What is the best way to prepare shellac for patterns? A.—The way with which we are familiar is to simply dissolve the dry shells in alcohol, and dilute with alcohol to any required consistency. The shells dissolve quite slowly, requiring usually a day or so. If kept in a warm place the process is hastened, but the alcohol evaporates more rapidly. It should be kept tightly covered.

(61) W. C. L. asks for information regarding the tempering of large milling saws, his own being 24 inches diameter by 3-16 inch thick. A.—The principal requirement for this work is a furnace which gives a uniform heat to all parts of the saw, the quenching being done in water or brine, and the saw being then drawn to the proper temper. The method is simple, but the apparatus is expensive, and the element of experience cuts a very large figure.

(62) J. J. H., Milwaukee, Wis., asks of what mineral the Arkansas and Washita oilstones are composed. A.—These stones are of the mineral called "Novaculite." The rock consists of extremely minute grains of quartz, among which are small cavities left by the dissolving out of calcspar crystals that were originally in the rock. Volume III of the Arkansas Geological Survey Reports for 1890 treats of the novaculites and all other whetstones. The volume can be obtained of the Secretary of the State of Arkansas, at Little Rock.

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The following examinations will be held at the New Criminal Court Building, N. Y.: On May 13th, at 10 A. M., for Mechanical Draftsman; on May 18th, at the same hour, for Engineer Inspector of Paving, Regulating and Grading; and on May 25th, also at 10 A. M., for Civil Service Examiner in Mechanical Engineering.

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At the Case School of Applied Science, Cleveland, two students are making experiments upon the bursting of fly-wheels as a basis for graduating theses. The wheels are, of course, small and driven by a steam turbine, the speed of revolution being determined by the tones produced. A wheel 15⅛ inches diameter burst at 6,525 revolutions, or a rim speed of over five miles a minute. One piece of the rim shot through 4 inches of pine and 2½ inches into the hardwood floor.

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Commercial Review.

NEW YORK, SATURDAY EVENING, MAY 1.

DYNAMOS AND MOTORS.

Business in the electrical machinery line is holding its own with a satisfactory degree of stability. We have just obtained brief reports from the standpoints of a good proportion of the most important concerns doing business in this market, and several of them are shown to be carrying on a hustling trade. The ex-

periences of the different companies are varied. One or another has good sales or inquiry to report in street railway machinery, in small motors, in power-transmission machinery, in small dynamos for lighting factories, etc. One, while considering the situation as perhaps on the mend, deplores the reluctance manifested in regard to placing orders. Some pronounce lighting dynamos a little quiet for the time being. A fan motor house reports less disposition on the part of jobbers to lay in stocks than at this time last year. A representative of one of the largest of the electrical corporations remarks, in a general way, that never before, does it seem, have there been so many new departures in electrical power machinery.

The street railway equipment work is spoken of favorably by most of the few companies which engage in it extensively. As a matter of fact, it is doubtful whether the amount of business in that line, this year, is much or any ahead of last year, which was not a good one. But some people seem to find it so. At any rate, the statements which we have heard have not been of a complaining nature.

Among recent street-railway contracts in this vicinity, we may mention that the Staten Island Traction Company, whose engine and boiler purchases were alluded to last week, has contracted for an 800-kilowatt Walker dynamo, and will procure some motor equipments from the General Electric Company. The Consolidated Traction Company, of New Jersey, also has ordered fifty of the General Electric's motor equipments.

An installation now just about completed, which offers, possibly, some novelty, is that of Crocker-Wheeler dynamos for lighting the New York Athletic Club's building. Three 30 and one 50 kilowatt machines are driven by one shaft, which is connected by friction clutches to two engines, either of which alone is sufficient to run them. In addition there are three 50-kilowatt generators directly connected to engines.

It is surprising how many changes have been made, during a few weeks past, in the location of local electrical sales offices. Those who may have occasion to do business with them should bear in mind the following removals: The Bullock (formerly Card) Electric Mfg. Company has, during the winter, taken offices in the St. Paul building. H. B. Coho & Co., who sell Eddy dynamos, have just moved to the same building. The two branches of the Crocker-Wheeler Electric Company which formerly were on Liberty street, have been drawn under the wing of the main office, at 39 Cortlandt street. They are in the charge, respectively, of Messrs. Blackall & Baldwin and Mr. Thos. J. Fay. The Walker Company has moved to the northwest corner of Wall and Nassau streets. The latest change, one which has taken place to-day, is that of the

(*Continued on page 35.*)

Business Specials.

Gear wheels, gear cutting. Grant; see page 16.

Forming Lathes. Mer. Mach. Tool Co., Meriden, Ct.

Engine Castings ¼ to 2 H. P. Finished boilers and engines. Grant Sipp, Paterson, N. J.

Send $1 to the Tabor Mfg. Co., Elizabeth, N. J., for improved stop-motion revolution counter.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

▲ ▲ ▲

Wants.

Situations and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday Morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Situations Wanted.

A mech. eng., grad. of a Ger. univ., wishes pos. as draftsman; mod. sal. Box 194, Am. Mach.

Fdy. foreman, agricultural shop prfd.; sober; refs.; understands all points. Box 559, La Grange, Ill.

Position as supt. or foreman by an up to date hustler, engines or pumps Box 195, Amer Mach

All-round tl. & die mk., always wkd. in N. E. States, would like to go to Wstn. city. Box 207, Am. Mach.

Mech. draftsman and designer, tech. grad., exper. machinist, wants pos. Box 201, Amer. Machinist.

Mill engineer wishes position; references and statement of past experience furnished. Address Box 191, American Machinist.

A mech. eng'r, with wide experience on light machinery and tools, wants a Western position as superintendent. Box 187, American Machinist.

First class draftsman and pattern maker wants position where good practical knowledge of both trades would be appreciated. Box 203, Am. Mach.

Wanted, by experienced engineer, pos. adjusting and testing engs.; snaft govs. a specialty; design if desired; $18 per week. Address Box 200, Am. Mach.

Machinist, thorough experience on machine tools, detail and erecting, w nts position; experienced on piece work. Address Box 197, Am. Mach

A factory supintendent with 8 years' experience in bicycle factory and 6 years in general machine shop in that capacity is open for a position. Address Box 199, American Machinist.

Mech. eng. 30, wide experience and education, mem. A.S.M.E., owns valuable pats. on gas engs. for direct cp'd. elec. serv., desires con. with subl. concern needing eng. or supt. Box 198, Am. Mach.

A party with a number of years' exp. in mfg. companies desires a situation as assistant to some mfg. co. Details and management of help pref. Ref. furn. Ad. M. W. C., P. O. Box 1829, Boston, Mass.

Mech. eng'r, age 43, desires change June 1. Specialty: Invention of processes and mach'y for reduc. mfg. cost. Also exp. in design and erection of power plants and elec. mach'ry. Box 190, Am. Machinist.

Situation Wanted—By all round machinist of 25 years' experience; 15 years constructing and erecting ice refrigerating plants; position in shop or as outside man; best of references given as to ability and character. Box 208, American Machinist.

Wanted—Position as supt. or asst. by man with wide experience in shop management; good manager and a pusher; designer of special tools, etc., on Corliss and auto. engs., electrical, rolling mill, general heavy and experimental work; strictly temperate; age 36. Box 196, American Machinist.

Help Wanted.

Wanted—George H. McDonald to write to Caleb Miller, No. 1 Fenchurch Street, Norfolk, Va.

Wanted—A draftsman on general work. Write giving experience and wages expected. Address Box 202, American Machinist.

Wanted—Two mechanical draftsmen who can design and detail machinery; state experience, reference and wages. Box 206 American Machinist.

Wanted—Machine tool contractor; thoroughly practical and capable of handling 50 men, to manufacture engine lathes, and with enough money to buy a one half interest; business well established. Address Box 204, American Machinist.

Wanted—An assistant supt. for machine shop near New York employing 250 men making mchy. of medium weight; must be well up in modern practice and be able to obtain the best results in quality and cost; to insure consideration applicants must give references, experience, age and salary expected. Address Box 205, American Machinist.

Miscellaneous Wants.

Advertisements will be inserted under this head at 30 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d h'd lathes & planers. S. M. York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

The Dutton Wet Twist Drill Grinder is sold by the Garvin Machine Co., New York City.

Best and cheapest Bolt Header, made by Baush & Harris Machine Tool Co., Springfield, Mass.

Models, experimental and small special machy. built. Write to Crocker & Lawson, Binghamton, N. Y.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Boye, Cincinnati, O.

We make a specialty of Shartle's patent safety set collars. Prices low and samples free. Middletown Machine Co., Middletown, Ohio.

Wanted—Every reader of this paper to send 35 cents for The Tool Catalogue. See Montgomery's advertisement on page 37 of this edition.

Wanted—A machinist would like to hear of a growing town that is in want of a jobbing shop. Address Box 192, American Machinist.

Wanted—Pattern maker as partner, with $300 to $1,000, in fdn dry. Correspond with Foundry, East Third and Pope Avenue, St Louis, Mo.

Wanted—The address of every young man who wishes to study mechanical engineering at a low cost. Mech. Dept., Agricultural College P.O., Mich.

Model Locomotives—Complete castings, latest N. Y. Cen. standard, up to date; 4c. in stamps for catalog. G. H. Olney, 163 Herkimer St., Brooklyn, N. Y.

For Sale—On account of death of owner, well equipped machine shop doing good business. Price, $2,800. Address M. Millard, 225 Case Avenue, Cleveland, Ohio.

Wanted—An Idea. Who can think of some simple thing to patent? Protect your ideas; they may bring you wealth. Write John Wedderburn & Co., Patent Attorneys, Washington, D. C., for their $1,800 prize offered to inventors.

Wanted—To correspond with parties having article of manufacture now made on contract which could be further developed under the favorable conditions we have to offer. Would also like to hear from firm open to change whereby an established bus. may be increased. Cheap power and low rents, or increased capital if investigation warrants. Confidential. Address, Board of Trade, care Am. Mach.

DRAFTSMAN'S HANDY PROTRACTOR.

AND OTHER NEW CONVENIENCES.

SEND FOR CIRCULARS.

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NEW HAVEN, CONN.

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How to Apply for a Patent. Price $1.00.

Complete cases including Patent Office actions; all necessary forms; instruction in wording claims, to afford the best protection. Post free on receipt of price. Sample pages on request. Address,

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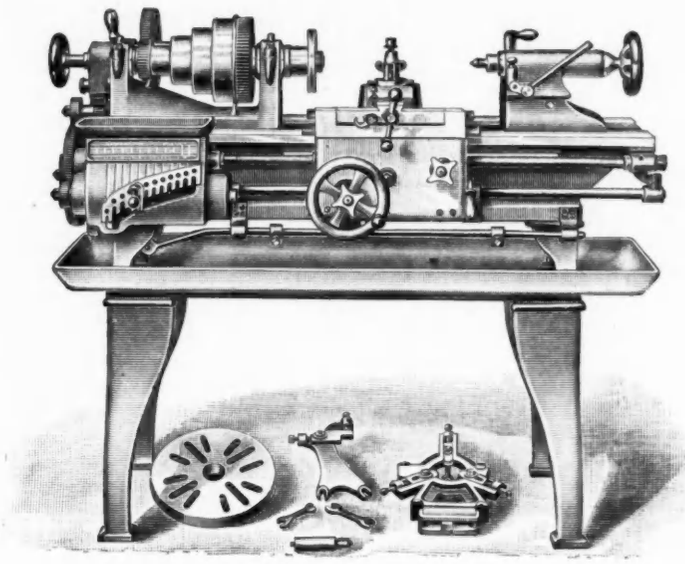
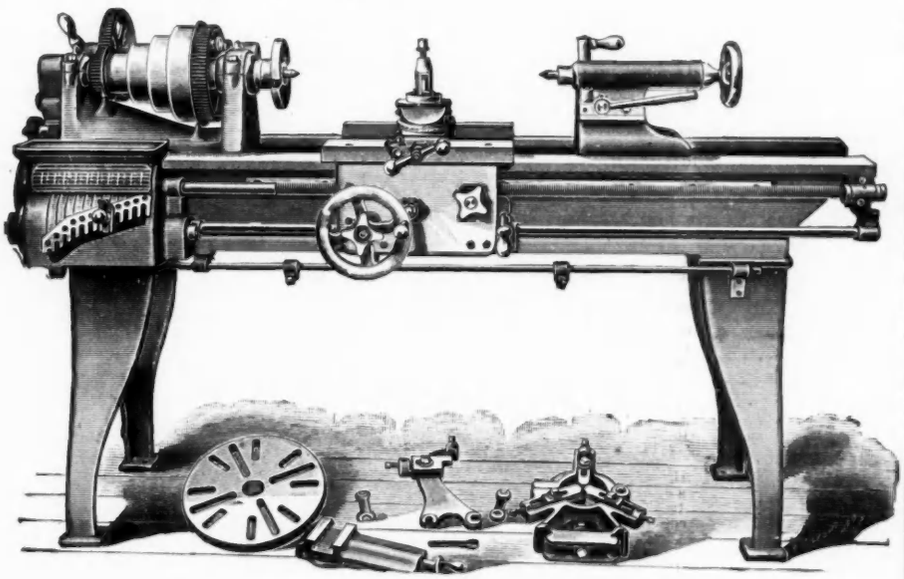
RARE OPPORTUNITY.

MANUFACTURING PROPERTY, in perfect order, for sale or to let. Very substantial buildings, with slate roof, high ceiling, many windows, steam heated, complete with engine, boiler, line shafting with adjustable hangers and split pulleys. Blacksmith shop with forges. Carpenter or pattern-making shop with shafting. Fire proof building for storing patterns or finished stock. Draughting room complete. Three offices. Ample sheds for storing materials. Large lot. Four trunk lines of railroads in all directions. Daily boats north and south. 1½ hours from New York City by railroad. Suitable for any business. Will alter to suit tenant if necessary. There is also a complete foundry which can be attached to property if desired. Strikes unknown. Wages very reasonable. Have plan of property. "OWNER," office of The "American Machinist," 256 Broadway, New York.



12" Hendey-Norton Lathe

is fitted with drawing-in sleeve and American Watch Tool Co's standard chuck, used in making small taps, reamers, etc. Work finished first and cut from bar afterwards. No centering required. See carriage reverse lever by right-hand side of apron; no reaching for countershaft shipper required.



14" x 6' Hendey-Norton Lathe.

These lathes are modern, high-grade, practical tools, and are specially adapted for tool-room work. They have the Norton Attachment for screw cutting, giving 36 different threads and 36 different feeds with only two changes of gear and movement of lever in gear-box from one notch to the other. Note the automatic stop under apron. It will automatically stop carriage at any desired point in either direction; invaluable for internal or duplicate work. SEND FOR CATALOGUE.

The Hendey Machine Company,
Torrington, Conn.

Agents for the Pacific Coast, Pacific Tool & Supply Co., San Francisco, Cal.

European Agents: Chas. Churchill & Co., London and Birmingham, Eng.
Schuchardt & Schutte, Berlin and Vienna.
Eugen Soller, Basel, Switzerland.

(Continued from page 34.)

Holzer-Cabot Electric Company's store from 114 to 112 Liberty street.

GOOD NEWS ALONG OTHER LINES.

An important Western machine-tool concern informs us that, while export demand is rather slack, domestic trade manifests a tendency to improve.

Another engineering establishment in the central West, the Robinson Machine Company, Monongahela City, Pa., is working so hard night and day to keep up with orders, as to suggest that, if trade increases in the same ratio that it has done, an enlargement of their plant is a thing to be considered.

The Buffalo Forge Company write us of an order received by them from St. Petersburg, Russia, for two electric lighting engines. They note a steadily growing demand for these engines, at home and abroad, especially in foreign markets. In spite of the fact that they have made little effort to sell them, their engine department has been very busy during the dull times of the past few years, and they contemplate important additions to their plant.

THE COMMERCIAL IMPORTANCE OF ELECTRICAL MACHINERY TO MACHINISTS.

The subject of dynamos and motors may appear to some machinists as rather remote from that of machine tools. For this reason we would call especial attention to the following presentation for us by Mr. Arthur M. Lozier, M. E., of the present status of the electrical machinery market, showing its relations to other machinery, in a monetary sense, and setting forth the claims of the electrician: "It has been said that the consumption of iron is a reliable indicator of the commercial prosperity of this country, but it is not more so than the demand for electrical machinery. The gratifying reports of the past month relating to the development of the electrical trade [this, it should be noted, was written from the standpoint of the Bullock Electric Mfg. Company, who have been doing an especially good business lately] show that a healthy recovery of almost all industrial enterprise is an assured fact. In the larger cities, and especially New York, the extensive building operations have contributed a most powerful impetus to the manufacture of electric-lighting apparatus and motors. Indeed, some of the office buildings and hotels require as many lights as five or six thousand, besides many horse-power in elevator and other motors. But it is not so much in electric lighting that the progress has been made; it is in the enormous field of power transmission for manufacturing and publishing establishments, which has been opened up within a comparatively short time. A history of the development of this branch is extremely interesting, since it illustrates, perhaps better than anything else, the progress of the times. A few years ago

the industrial world reached that condition where profit was to be made not so much in the articles manufactured as in the petty saving in power, time and by-products. No one will deny that the great improvements in tools and appliances in the factory have enabled many establishments to make more money, even at reduced prices for their product, than in the so-called golden days when crude processes of manufacture went hand in hand with high prices.

"When electrical transmission stepped to the fore, even the best equipped factories presented a most inconsistent appearance. Their condition might be compared to two strong iron links of a chain held together by a piece of string, for on the one hand their boilers and engines were of the best and most economical types, and on the other hand, their tools or printing presses were compact, automatic and highly efficient. But the connecting link, the means of transmitting the power from the engine to the tool, was a weak one, a great source of waste in power and a relic of conservatism. It is astounding that for years, thousands (indeed, one may say millions) of horse-power hours have been wasted in the mere friction load of shafting and belting, without any serious consideration of the matter by mill owners and printers.

"Records of tests made in over two hundred representative factories and printing establishments of this country alone show, as an average, that about fifty per cent. of all the power generated by the engines has been wasted in belt or rope transmission of power.

"To-day, however, all is changed, for the direct-connected slow-speed motor is making the chain perfect, and is permitting old as well as new factories not only to make enormous saving in the coal pile by doing away with all shafting and belting, but to obtain increased facilities for using the machinery at a much higher rate of output than was formerly obtained.

"These facts are coming to be recognized very rapidly by progressive manufacturers, and it is now a very common experience to see large and small establishments in which each tool or press or countershaft is operated by a slow-speed direct-connected motor, the electric power being supplied from a large and economical power-generating plant located at the point most convenient for handling fuel and water. We seem to be entering a beltless, as well as horseless age."

Quotations.

NEW YORK, Monday, May 3.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$11 75 @ $12 25
No. 2 foundry, Northern	11 00 @ 11 50
No. 2 plain, Northern	10 25 @ 10 50
Gray forge, Northern	10 00 @ 10 25
No. 1 foundry, Southern	10 50 @ 10 75
No. 2 foundry, Southern	10 00 @ 10 25
No. 3 foundry, Southern	9 75 @ 10 00
No. 1 soft, Southern	10 25 @ 10 50
No. 2 soft, Southern	10 00 @ 10 25
Foundry forge, or No. 4, Southern	9 25 @ 9 50

Owing to freight reductions and to the fact

(*Continued on page 37.*)

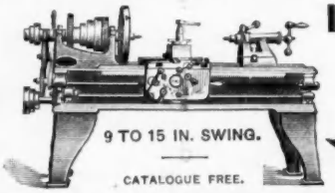
The Pratt & Whitney Co. HARTFORD, CONN., U.S.A.

...MAKERS OF...

Fine Machine Tools.

Complete Plants furnished for Bicycle, Typewriter, Gun and Sewing Machine Makers. Gauges and Small Tools for all Machine Work. Drop Hammers and Trimming Presses. Forging and Trimming Dies for all classes of work.

England—Buck & Hickman, 280 Whitechapel Road, London, E. *France*—Fenwick Freres & Co., 21 Rue Martel, Paris. *Chicago*—42 and 44 South Clinton Street. *Boston*—281 Franklin Street. *New York*—123 Liberty Street.



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Our tools are all of the latest and most approved designs, while the workmanship, material and finish are of the highest order. You will find it an advantage to have our catalogue and special prices before placing your order.

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Fourteenth Edition. Rewritten and Reset. 12mo, $2.50.

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THE TAPS PASS CLEAR, MAKING FULL
THROUGH THE NUTS, FINISHED THREADS
THE GREEN RIVER SCREW PLATE.
DIES ALWAYS READY
TRUE TO SIZE
PERFECT SCREWS AT A SINGLE CUT

FINE SCREW PLATES.

"Lightning" and "Green River."

Taps, Dies, Reamers, Tap Wrenches Bolt Cutters, Drilling Machines, Punching Presses and other labor saving Tools. Send for Catalogue.

WILEY & RUSSELL MFG. CO., - - Greenfield, Mass.
Agents in London, SELIG, SONNENTHAL & CO., 85 Queen Victoria Street. U. S. A.

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PATENT SOLICITORS, 36 WALL ST., N.Y.

Have done all my patent soliciting work, both for this and foreign countries, continously for the past fourteen years.
Thomas A. Edison

STAR LATHES
★★★
Foot Power Screw Cutting, Automatic Cross Feed, 9 and 12" Swing.
Send for Catalog B.
Seneca Falls Mfg. Co.
697 Water St., Seneca Falls, N.Y.

WE CLAIM THE FOLLOWING MERITS FOR JENKINS BROS.' VALVES.

1. Manufactured of the best Steam Metal.
2. No regrinding, therefore not constantly wearing out the Seat of the Valves.
3. Contain JENKINS DISC, which is suitable for all Pressures of Steam, Oil and Acids.
4. The Easiest Repaired, and all parts Interchangeable.
5. Every Valve Tested before leaving the factory.
6. ALL GENUINE stamped with Trade Mark.

JENKINS BROTHERS, New York, Philadelphia, Chicago, Boston.

NORTON EMERY WHEEL CO. EMERY WHEELS.

ILLUSTRATED CATALOGUE FREE.

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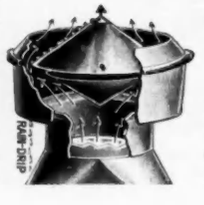

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PRYIBIL'S COLUMN.

NEW IMPROVED BUZZ PLANER.

A very excellent improvement on this machine is the hand lever, as shown in cut, by which means the table can be set instantaneously to take any thickness of cut required to one-half inch, thereby saving a large amount of time and wearing of knives, as would not be the case where the table was adjusted by means of a hand wheel or screw. Lumber having large wind, or very crooked, required to be planed three or four times before a smooth surface is obtained, where with this machine by means of the lever, the table can be set to take one rough cut and then set to take one finishing cut.

Machine can be used for beveling, squaring, smoothing, tonguing, grooving and moulding. Cutter-head is provided with I slots. Table can be set to plane slightly hollow, so that when work is glued up, it will be extra tight at the ends and less liable to open. Made in four sizes, viz.: 9", 14", 18" and 26". The 14", 18" and 26" machines have a bed 8' long; cutter-head making 6,000, 5,500 and 5,000 revolutions respectively.

ADJUSTABLE SQUARE AND BEVEL BAND SAW.

Saw can be inclined from 0 to 45 degrees by turning a single handwheel. Parts remain locked in any position. Clamping unnecessary. VARYING BEVEL can be produced while work is being sawn.

P. PRYIBIL, 512-524 West 41st Street, NEW YORK CITY.

We manufacture a complete line of

DRILLS

for light work, one or more SPINDLES, hand or automatic feed, of thorough workmanship and strictly up to date.

Prompt delivery on regular styles.

New Catalogue on application.

DWIGHT SLATE MACHINE CO.....

HARTFORD, CONN.

Chas. Churchill & Co., Ltd., London and Birmingham. Schuchardt & Schutte, Berlin, Germany.

POWER PRESSES

Punches and Shears,

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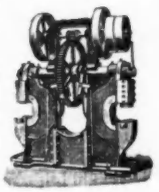

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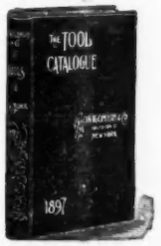
GODFREY J. BREMER MACHINE CO.

KALAMAZOO, MICH., U. S. A.

Write for Catalogue "A" and Price List.



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(Continued from page 36.)

that low prices have for some time been made privately, the changes in quotations are more apparent than real.

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▲ ▲ ▲

Manufactures.

At Forest City, O., Mr. Wright is expecting to erect a machine shop.

The Botany Worsted Mills, Passaic, N. J., expect to add new machinery.

At Webster, Mass., the plant of H. N. Slater will have an addition erected.

The Whitehead-Hoag Company, of Newark, N. J., is about to enlarge its plant.

At Bethlehem, Pa., Mr. C. W. Finady contemplates the erection of a factory.

The boiler shop of John Mohr & Sons, Chicago, was recently destroyed by fire.

At Joliet, Ill., the McKenna Steel Working Company will erect a new rolling mill.

The boiler shop of E. Rial & Son, at Franklin, Pa., was recently destroyed by fire.

The plant of Maxwell Clower, at West Chester, Pa., was recently destroyed by fire.

The sawmill at Oakfield, O., owned by Christopher Strom, has been destroyed by fire.

At Philadelphia, Pa., Mr. E. P. Gallagher has commenced the erection of a factory.

At Grand Crossing, Ill., the Grand Crossing Tack Company's plant has been burned out.

Mr. Lewis Havens, of Philadelphia, Pa., contemplates the erection of a new factory.

Mr. E. E. Gill, Port Clinton, O., will equip his mill with the latest improved machinery.

The W. W. Kamball Company, of Chicago, Ill., will soon make an addition to its plant.

The Gill Glass Company, of Philadelphia, Pa., will erect a large gas plant at Jeannette, Pa.

At Dickson, Tenn., the Dickson Foundry & Machine Shop has recently been destroyed by fire.

James H. Lyons, of Philadelphia, will build a pottery ware manufactory near Camden, N. J.

A new iron company, known as the Wyoming Iron Mining Company, has been incorporated.

The Comet factory at Waltham, Mass., is contemplating the erection of an addition to their plant.

The Norton Nail Company, of Ashland, Ky., will erect a large rod mill some time during the summer.

At Winchester, Ind., the American Manufacturing Company of California will erect a tinplate factory.

The chemical factory of Feuchtwangel & Co., at Long Island City, N. Y., was recently destroyed by fire.

The Indiana Iron Works, at Muncie, Ind., were visited by fire recently, and $10,000 damage was done.

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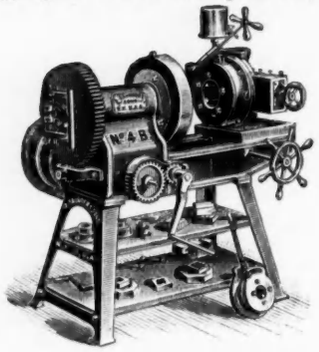

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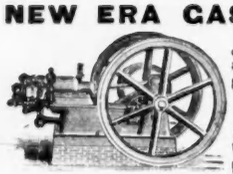

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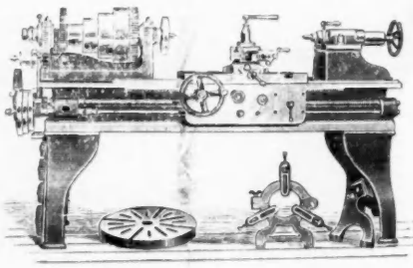

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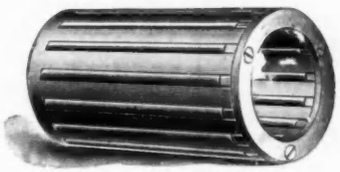

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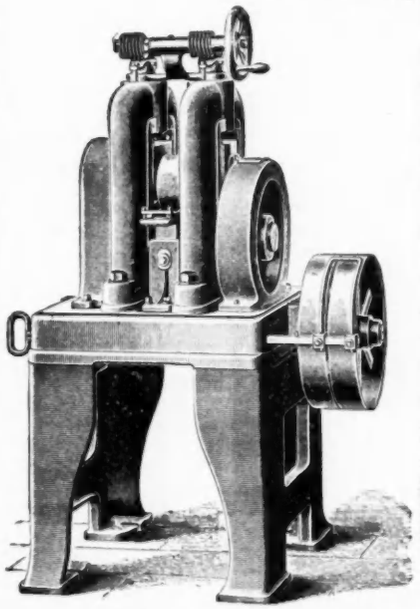

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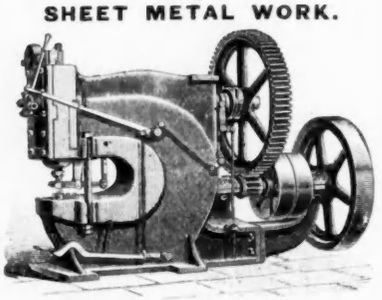
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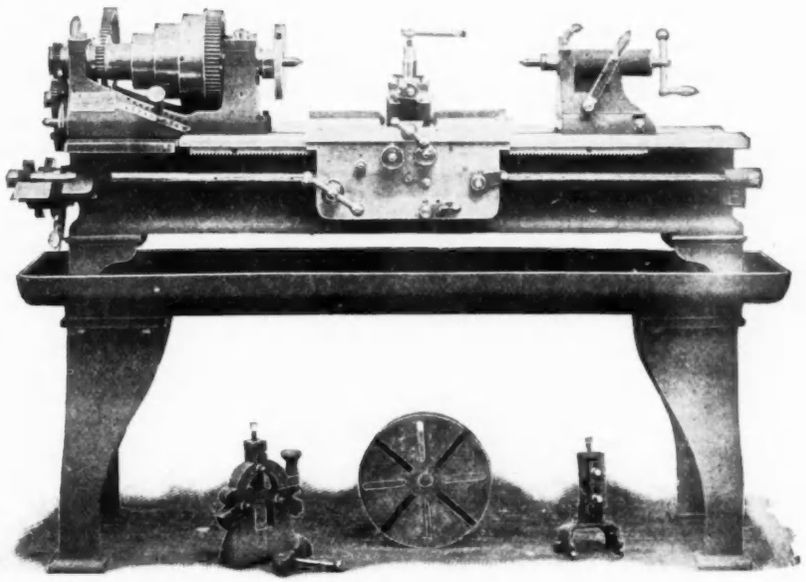

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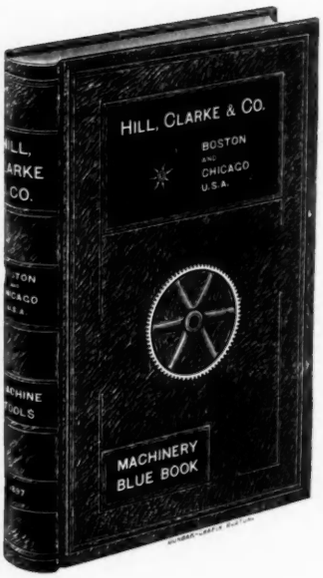

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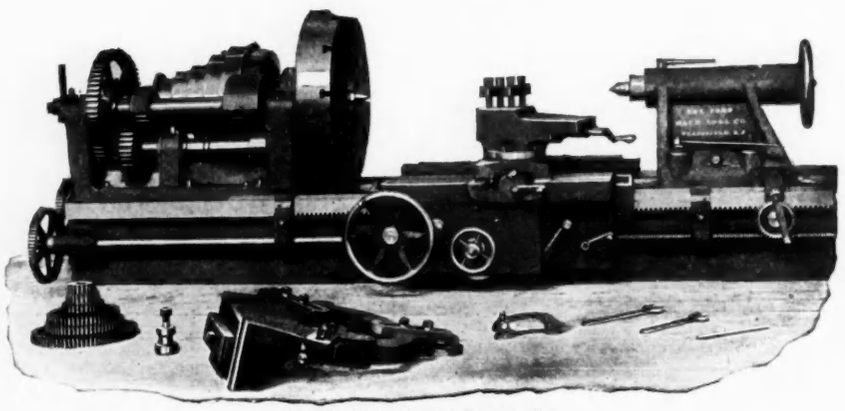

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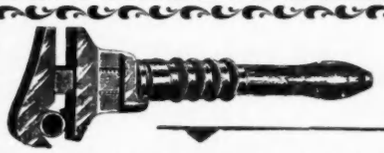

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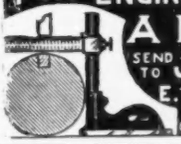

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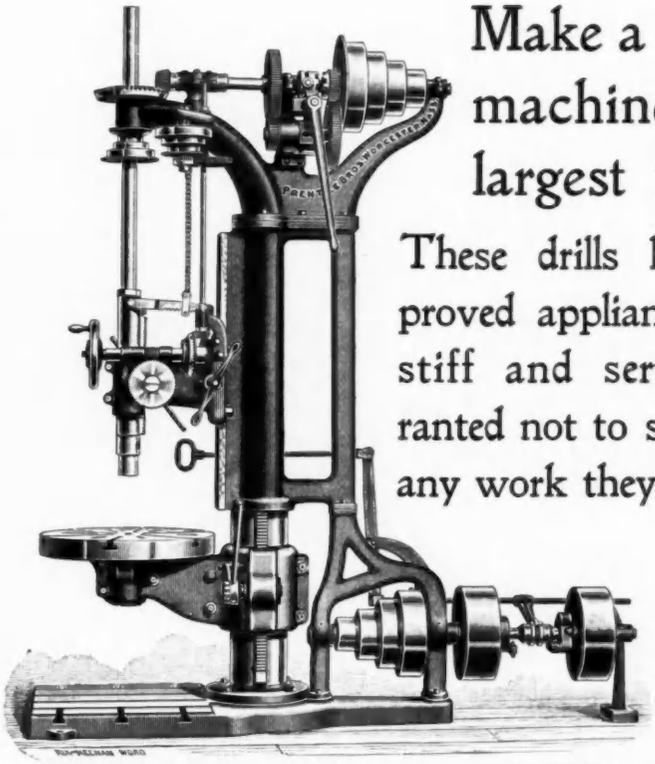

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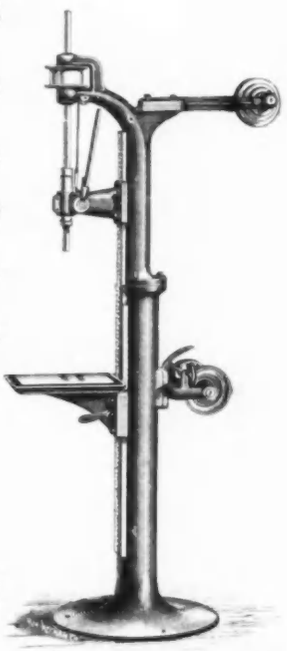

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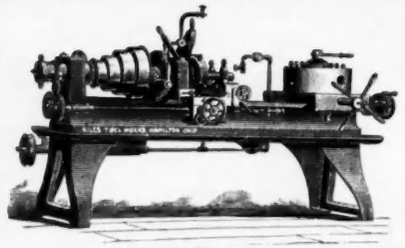

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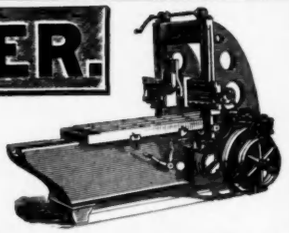

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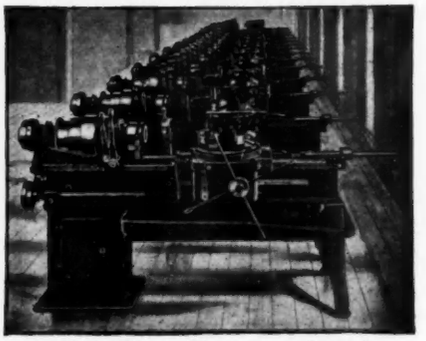

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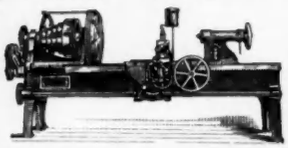

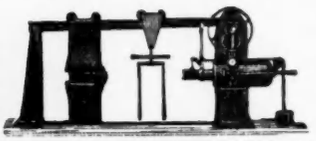

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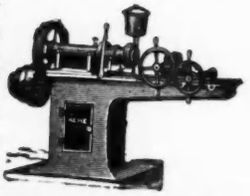

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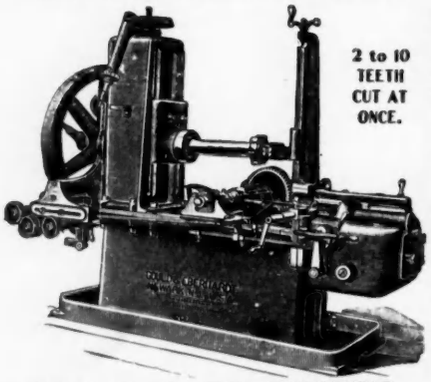

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